nce Abstracts

Section A

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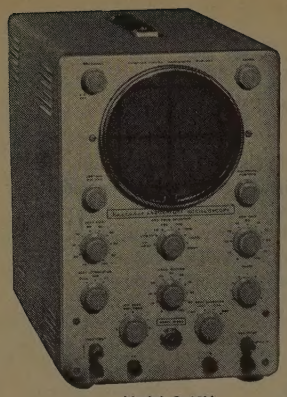

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Peak Reverse Voltage (Volts)	25	50	75	100	150	200	250	300
Max. Mean Forward Current (Amps)*	100	100	100	100	100	100	100	100
Max. Recurrent Peak Forward Current (Amps)	500	500	500	500	500	500	500	500
Max. Forward Voltage Drop at 350 Amps Peak (Volts)	2	2	2	2	2	2	2	2
Max. Trigger Firing Current Required (Amps)	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4
Max. Trigger Firing Voltage Required (Volts)	4	4	4	4	4	4	4	4
Max. Peak Trigger Current (Amps)	2	2	2	2	2	2	2	2
Max. Mean Trigger Current (Amps)	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6
Peak Forward Trigger Voltage —anode + ve (Volts)	10	10	10	10	10	10	10	10
Peak Forward Trigger Voltage —anode —ve (Volts)	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25
Peak Reverse Trigger Voltage	5	5	5	5	5	5	5	5

80-AMP TYPES CR80-	21	51	71	101	151	201	251	301
Peak Forward Working Voltage (Volts)	25	50	75	100	150	200	250	300
Peak Reverse Voltage (Volts)	25	50	75	100	150	200	250	300
Max. Mean Forward Current (Amps)*	80	80	80	80	80	80	80	80
Max. Recurrent Peak Forward Current (Amps)	500	500	500	500	500	500	500	500
Max. Forward Voltage Drop at 350 Amps Peak (Volts)	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5
Max. Trigger Firing Current Required (Amps)	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4
Max. Trigger Firing Voltage Required (Volts)	4	4	4	4	4	4	4	4
Max. Peak Trigger Current (Amps)	2	2	2	2	2	2	2	2
Max. Mean Trigger Current (Amps)	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6
Peak Forward Trigger Voltage—anode + ve (Volts)	10	10	10	10	10	10	10	10
Peak Forward Trigger Voltage—anode—ve (Volts)	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25
Peak Reverse Trigger Voltage	5	5	5	5	5	5	5	5

*At a conduction angle of 180° and base temperature of 50°C.

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Temperature: The provisional curve for derating with temperature is shown below.

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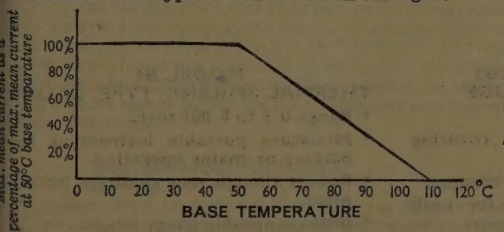

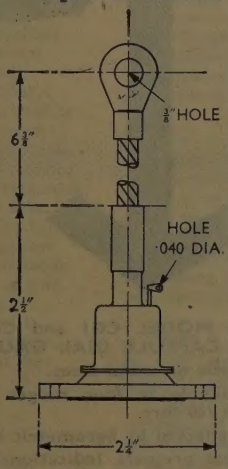

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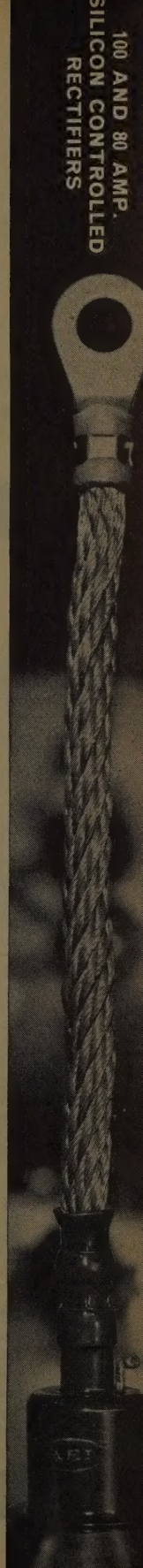

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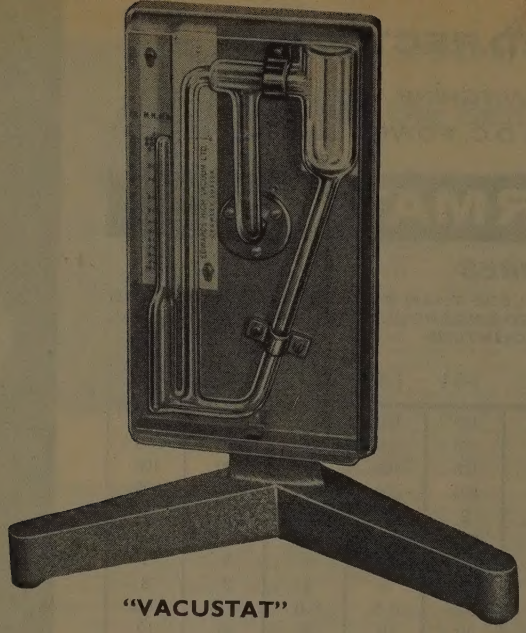

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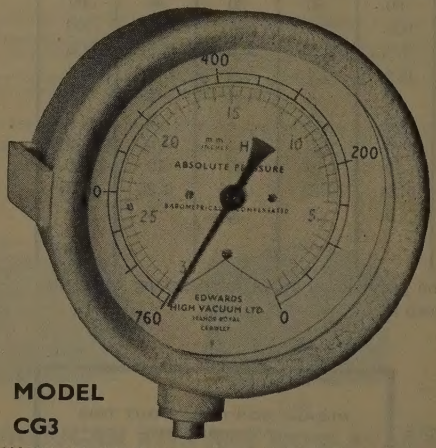

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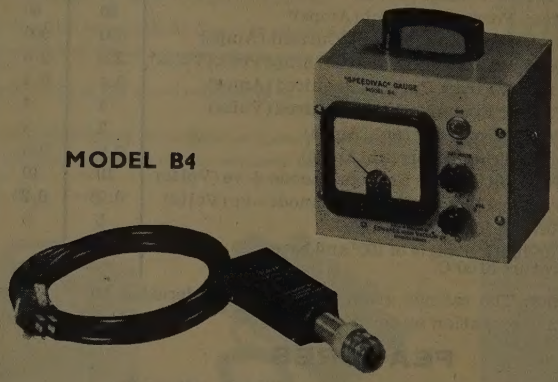

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PHYSICS ABSTRACTS

olume 64 SEPTEMBER 1961 Number 765

MATHEMATICS

10366 GEOMETRICAL APPROACH TO THE THEORY OF PROBABILITY. D.McLachlan, Jr and L.L.Chamberlain.
ner. J. Phys., Vol. 29, No. 7, 385-92 (July, 1961).

The purpose of this paper is twofold: first, to present an eresting geometrical approach to the derivation of some familiar uations in the theory of probability, and second, to use this newer proach for extending the scope of the equations. Particularly, e aim is to extend the well-known problem of how many ways ere are of distributing m identical objects among n numbered boxes with no more than one in each box to the problem of distributing the m objects in n boxes with no more than M in each box. The solution of this more general problem of M as the limiting number per box is expressed as a mathematical series involving factorials.

"FOURIER SERIES CHARGE DENSITY INTEGRAL SOLVING TECHNIQUE". See Abstr. 10659

ASTROPHYSICS

10367 INTERSTELLAR AND INTERPLANETARY COMMUNICATION BY OPTICAL MASERS.
.N.Schwartz and C.H.Townes.
ature (GB), Vol. 190, 205-8 (April 15, 1961).

It is shown that interplanetary communication with light is ready just feasible. With the rapid advances that can be expected ow that optical masers have been shown to work, long range optical ommunication could prove more effective than radio in space. In ny search for signs of a similarly advanced society to our own on lanets of stars within 10 light years, optical masers should be sed. D.Walsh

10368 AN EXAMINATION OF THE STEADY-STATE MODEL IN THE LIGHT OF SOME RECENT OBSERVATIONS OF RADIO SOURCES. M.Ryle and R.W.Clarke.
Monthly Not. Roy. Astron. Soc. (GB), Vol. 122, No. 4, 349-62 (1961).

The results of some recent observations of radio sources were sed to investigate the "luminosity function" for the sources. Without aking any assumptions about their nature, it can be shown from adio observations alone that most of the sources lying in any iven range of flux density are extragalactic with an emission at 78 Mc/s which exceeds 10^{24} W $(c/s)^{-1}$ sterad^{-1}. If it is assumed ither that the physical dimensions or that the optical luminosities f the sources are comparable with those of the Galaxy, then the mission must lie in the range 3×10^{25}–10^{27} W $(c/s)^{-1}$ sterad^{-1}. rom these figures it is possible to derive the expected number-lux density relationship according to different cosmological models nd special consideration is given to the predictions of the steady-tate model. With the new Cambridge interferometer it has become ossible to observe sources considerably weaker than those reached n earlier surveys, and hence to make a more accurate determination ion of the actual number-flux density relationship; the new data lso allows more detailed corrections for the effects of extended ources and source clustering to be made. A comparison of these bservational results with those predicted by the steady-state model hows a marked discrepancy, the number of sources observed with a flux density in the range 0·5 to 2×10^{-26} W $(c/s)^{-1}$ m^{-2} being t least $3 \pm 0{\cdot}5$ times that predicted by the model. No attempt is nade to select an alternative model to account for the observations, ut the results appear to provide conclusive evidence against the steady-state model.

10369 NEUTRINO AND COSMOLOGY. A.Peres.
Progr. theor. Phys. (Japan), Vol. 24, No. 1, 149-54 (July, 1960).

The elementary relativistic cosmological model is refined by taking into account the proper motions of particles. It is found that the latter were in the past much faster than now, and it is thereby inferred that there must actually exist, in our universe a large population of low-energy neutrinos, due to previous high-energy nuclear reactions. It is shown how these neutrinos can be detected through their gravitational influence. In case they fail to be detected, one must conclude that there exists a possibility of annihilation of neutrino—antineutrino pairs.

10370 THE COLLAPSE OF A CONTRACTING UNIVERSE. K.Just.
Z. Astrophys. (Germany), Vol. 52, No. 1, 13-17 (1961).

The known result that the speed of contraction tends to infinity with decreasing radius, in the case of model universes filled either with matter or with radiation, is found to hold also for a universe containing both matter and radiation and the possibility of an elastic rebound is excluded. R.A.Newing

10371 ON CONDENSATION PROCESSES IN THE EXPANDING UNIVERSE. K.Kraus.
Z. Astrophys. (Germany), Vol. 52, No. 1, 18-21 (1961).

From an application of a generalization of Jeans' criterion for gravitational instability to a "mixture cosmos" containing both matter and radiation, it is concluded that the critical mass for a condensation is independent of time in the early stages of expansion, and estimates of the critical mass are found to be consistent with present estimates of galactic masses. The rate of condensation remains too slow for the formation of galaxies from thermodynamic fluctuations. R.A.Newing

10372 STREAMING OF INTERSTELLAR HYDROGEN IN THE VICINITY OF THE SUN.
R.X.McGee, J.D.Murray and J.L.Pawsey.
Nature (GB), Vol. 189, 957-9 (March 25, 1961).

A preliminary report based on hydrogen line observations which were completed over the whole sky from Sydney. At high galactic latitudes it is found that neutral hydrogen is apparently streaming towards the sun, whereas at lower latitudes, the gas flows away from the sun in the direction of the galactic centre and the anti-centre. H.J.A.Chivers

10373 DEUTERONOMY. SYNTHESIS OF DEUTERONS AND THE LIGHT NUCLEI DURING THE EARLY HISTORY OF THE SOLAR SYSTEM. W.A.Fowler, J.L.Greenstein and F.Hoyle.
Amer. J. Phys., Vol. 29, No. 7, 393-403 (July, 1961).

Abundances in terrestrial and meteoritic matter indicate that the synthesis of deuterons and of the isotopes of lithium, beryllium, and boron occurred during an intermediate stage in the early history of the solar system. In this intermediate stage, the planetary material had become largely separated, but not completely, from the hydrogen which was the main constituent of primitive solar material. Appropriate physical conditions were satisfied by solid

planetesimals with dimensions of the order of 10 m and consisting of silicates and oxides of the metals embedded in an icy matrix. The synthesis occurred through spallation and neutron reactions induced in the outer layers of the planetesimals by the bombardment of high-energy charged particles accelerated in magnetic flares at the surface of the condensing sun. The importance of the (n,α) reactions on Li^6 and B^{10} is indicated by the relatively low abundances of these two nuclei. Anomalous abundances of Xe^{129} and Ag^{107} observed in meteorites can be attributed to the decay of radioactive I^{129} and Pd^{107} produced in the planetesimals. The interval between the irradiation of the small planetesimals and the formation of large bodies in the solar system could not have exceeded 10^7 to 10^8 years.

10374 THE SCALE OF THE SOLAR SYSTEM.
Nature (GB), Vol. 190, 592 (May 13, 1961).

A new determination of the solar parallax by radar distance measurements of Venus was obtained during the planet's close approach to the Earth in April 1961. The equipment operated at 440 Mc/s, with aerial gain of 37.5 dB and a peak power of 2.5 mW. The signals were pulsed for 0.5, 2.0 or 4.0 msec. Received energy was integrated over different range intervals for a duration equal to the echo time so as to remove false echoes. Mean echo intensity was equivalent to a received power level of 163 dB below 1 mW, and corresponded to ~ 12% scatter from the planetary surface. Insufficient information on angular scatter made it impossible to derive a precise rotation period, although the results suggest a period equal to the synodic value of 584 days. Analysis of the results of 20 independent range observations between March 6 and April 12 gives a mean value for the solar parallax, 8.7945 ± ± 0.00008 compared with the earlier radar value of 8.8022 ± 0001 sec of arc. D.R.Barber

10375 SELECTED LUNAR OBSERVATIONS MADE AT THE PIC-DU-MIDI OBSERVATORY IN 1956 AND 1959.
G.Fielder.
J. Brit. Astron. Assoc., Vol. 71, No. 5, 207-14 (1961).

10376 THE EFFECT OF TIDAL FRICTION ON ECCENTRICITY AND INCLINATION. H.Jeffreys.
Monthly Not. Roy. Astron.Soc. (GB), Vol. 122, No. 4, 339-43 (1961).

Darwin's analysis (1880) for the effects of tidal friction on the eccentricity and inclination of a satellite's orbit is adapted to modern laws of imperfect elasticity and of friction in ocean currents. It appears that as the conditions make the lags in the tides nearly proportional to the speeds his results for small viscosity are qualitatively correct, since these have the same property. In particular the eccentricity and inclination of the Moon's orbit should now be increasing.

10377 ENHANCED LUNAR THERMAL RADIATION DURING A LUNAR ECLIPSE.
R.W.Shorthill, H.C.Borough and J.M.Conley.
Publ. Astron. Soc. Pacific (USA), Vol. 72, 481-5 (Dec., 1960).

Bolometric measurements of infrared lunar radiation were made at the Newtonian focus of the Dominion Astrophysical Observatory's 72-in. reflector during the total eclipse of March 12-13, 1960, in an attempt to discover regions of anomalous thermal characteristics; in particular, zones undergoing less rapid cooling than that of the general lunar surface. Three lunar features, Tycho, Aristarchus, and Copernicus, all rayed craters, showed enhanced thermal radiation during the eclipse. The mean rise of temperature in each instance was 50°K; and the effect is interpreted as being due to the thinner dust cover in the crater areas. D.R.Barber

10378 THE EVOLUTION OF THE MOON.
D.Alter.
Publ. Astron. Soc. Pacific (USA), Vol. 73, 5-14 (Feb., 1961).

10379 THE CLOUDS OF VENUS.
B.Warner.
J. Brit. Astron. Assoc., Vol. 71, No. 5, 200-1 (1961).

10380 THE OBSERVATION OF DETAIL ON THE PLANET VENUS. B.Warner.
J. Brit. Astron. Assoc., Vol. 71, No. 5, 202-5 (1961).

10381 DISSIPATIVE INTERACTION BETWEEN SATELLITES.
H.Jeffreys.
Monthly Not. Roy. Astron. Soc. (GB), Vol. 122, No. 4, 345-7 (1961).

Mutual influence of satellites through tidal friction is considered, and with modern evidence on the rate of tidal friction it appears that the effect is insufficient to explain approximate commensurabilities of mean motions. There is less difficulty in supposing that mutual influence through a resisting medium can have been important. Kuiper's theory (Vistas in Astronomy. London; New York; Paris: Pergamon Press, 1956, 1662-6) of the origin of Trojan planets appears to be inconsistent with the result that the triangular position is secularly unstable.

10382 THE ORBIT AND EPHEMERIS OF PERIODIC COMET OTERMA. B.G.Marsden.
Astron. J. (USA), Vol. 66, No. 5, 246-8 (June, 1961).

The orbit has been integrated on an IBM 650 over the forthcoming very close approach to Jupiter. An ephemeris for 1962-6 is provided and so are osculating values of the orbital elements a intervals during this period.

10383 EMISSION-BAND AND CONTINUUM PHOTOMETRY C COMET BURNHAM, 1959 k. C.R.O'Dell.
Publ. Astron. Soc. Pacific (USA), Vol. 73, 35-45 (Feb., 1961).

10384 MAGNETIC PROPERTIES OF THE YARDYMLINSK IRON METEORITE.
M.A.Kashkai, T.A.Ismail-Zade and V.I.Aliev.
Dokl. Akad. Nauk SSSR, Vol. 136, No. 3, 568-70 (Jan. 21, 1961). In Russian.

For abstract, see Abstr. 5140 of 1961. [English translation in: Soviet Physics—Doklady (USA), Vol. 6, No. 1, 1-2 (July, 1961)

10385 A STUDY OF SUNSPOT VELOCITY FIELDS USING A MAGNETICALLY UNDISTURBED LINE. J.Holmes.
Monthly Not. Roy. Astron. Soc. (GB), Vol. 122, No. 4, 301-9 (1961

The relation between magnetic lines of force and material motion is a matter of considerable importance in sunspot theory, and this investigation of sunspot velocity fields uses a line for wh the Landé splitting factor g = 0. (Fe I λ 5576.101). Doppler displacements were measured at over 100 points in the region of bo a large and small sunspot. At the high dispersion value of 0.17 A/m measurement difficulties are presented by the broad solar lines, but a check on visual accuracy was provided by a new photo-elect method of measurement. The measured velocities were correcte for observer's motion and solar rotation and reduced to velocity components, with origin at the spot centre. Using Kinman's conc sion [Monthly Not. Roy. Astron. Soc. (GB), Vol. 113, 613 (1953)] t the spot flow is wholly radial, fair agreement for the maximum radial velocity in the penumbra of the small spot was obtained bu value much smaller than that predicted by Kinman for the large s was found. The differences from the earlier measures were attr buted to the fact that the true Doppler shifts are now able to be m sured, freed from the complicating effects of Zeeman splitting, a also to the "line-flare", which appears in the penumbral region o high dispersion spectra, but was not resolved in the earlier work Evershed effect.

10386 MEASUREMENT OF THE NET ELECTRIC CHARGE ON THE SUN BY MEANS OF THE ARTIFICIAL PLA "PIONEER V". V.A.Bailey.
Planet. Space Sci. (GB), Vol. 5, No. 1, 70-1 (Jan., 1961).

Although it is generally assumed that bodies like the sun do not carry appreciable net electric charges, the hypothesis that such a body carries a negative charge of about $-0.03\ G^{1/2}$ M e.s serves to derive the known orders of magnitude and the related directions of several different astronomical phenomena. It is suggested that the magnetometric measurements made in the artificial planet Pioneer V should be used to test this hypothesis The magnetic field measured by the planet resulting from such a charge should vary as $Q/(\text{orbital radius})^3$, so that Q could be estimated and the dependence on the orbital radius used to test t hypothesis. H.Morri

10387 NOTE ON SOLAR, GEOMAGNETIC AND IONOSPHERI ACTIVITY. J.O.Cardús.
Rev. Geofis. (Spain), Vol. 19, 427-39 (Oct.-Dec., 1960). In Spanis

Describes the solar, magnetic and ionospheric events as observed at Tortosa (Spain) during the first three months of 1960 and compares them with the activity of the preceding three month At the end of 1959 solar activity was decreasing, but though there no perceptible increase in the total sunspot area in Jan.-March 19 the Wolf numbers were greater and the mean solar latitude of spo increased from 12° to 14°. Judged both by disturbance indices an the number of storms geomagnetic activity was slightly less in th first quarter of 1960 than it had been in the latter part of 1959. Tables give daily and mean values of solar, geomagnetic and eart

...t activity, monthly means of sunspot data, positions of sunspots ...eir evolution, principal magnetic disturbances and data for the ...here. J.M.Stagg

...HE COSMIC RAY FLARE ON NOVEMBER 12, 1960, AND SOLAR ...VITY DURING THE PERIOD NOVEMBER 10-15, 1960. ...bstr. 9788

...SHOCK WAVE PROPAGATION IN THE SOLAR CHROMO-...RE. See Abstr. 10774

10388 INFORMAL COLLOQUIUM OF THE I.A.U. SUBCOMMISSION 29a — THE PROFILES OF STELLAR ...TRAL LINES.
...Astrophys. (France), Vol. 23, No. 6, 805-978 (1960).
The colloquium was held at Meudon on Sept. 3-5, 1960. A total ... papers were divided between four sections: (1) Population of ...tomic levels; (2) Transfer of radiation in spectral lines; ...ning of lines; (3) Absorption line profiles; (4) Profiles of ...sion lines. Abstracts of papers will be found in this or ...eeding issues of Physics Abstracts.

10389 VEILED ABSORPTION LINES. F.M.Hawkins.
...thly Not. Roy. Astron. Soc. (GB), Vol. 122, No. 4, 285-300 (1961).
It has been suggested that some apparently faint Fraunhofer ... may not be faint in the theoretical sense, but may be formed ...w photospheric layers and "veiled" by a higher emitting ...sphere. This paper contains a theoretical investigation of this ...thesis. An exact solution is found for the residual intensity ...ect to certain standard though rather restrictive conditions. ...e concluding section line profiles are drawn for veiled lines ... for lines without veiling to show the effect of veiling on a ... profile.

10390 THE POSSIBILITY OF OBSERVING GASEOUS NEBULAE IN THE LYMAN α LINE. G.A.Gurzadyan.
...l. Akad. Nauk SSSR, Vol. 136, No. 5, 1055-8 (Feb. 11, 1961). In ...sian.
For abstract, see Abstr. 6722 of 1961. [English translation in: ...iet Physics—Doklady (USA), Vol. 6, No. 2, 95-7 (Aug., 1961)].

10391 THE AGE OF THE GALAXY. R.F.Churchhouse.
...rit. Astron. Assoc., Vol. 71, No. 5, 217-18 (1961).

10392 THE CLUSTERING OF GALAXIES. S.van den Bergh.
...bl. Astron. Soc. Pacific (USA), Vol. 73, 46-50 (Feb., 1961).

...adioastronomy

10393 THE SOLAR NOISE BURST OF NOVEMBER 12, 1960. A.E.Covington, G.A.Harvey and L.R.McNarry.
...nad. J. Phys., Vol. 39, No. 4, 635-6 (April, 1961).
Noise recordings on 2800 Mc/s and 48 Mc/s are presented. A ...e delay of about 190 sec was observed between the commence-...nt of the bursts on the two frequencies. H.J.A.Chivers

SOLAR RADIO EVENTS AND GEOMAGNETIC STORMS.
...e Abstr. 10341

10394 A NEW DETERMINATION OF THE SOLAR PARALLAX BY MEANS OF RADAR ECHOES FROM VENUS.
...H.Thomson, J.E.B.Ponsonby, G.N.Taylor and R.S.Roger.
...ture (GB), Vol. 190, 519-20 (May 6, 1961).
Observations during the recent close approach of Venus ...elded the value 8.7943 ± 0.0003 sec of arc. This is compared ...th other experimental values of the constant. H.J.A.Chivers

10395 RADAR ECHOES FROM VENUS AND A NEW DETERMINATION OF THE SOLAR PARALLAX.
...Pettengill and R.Price.
...anet. Space Sci. (GB), Vol. 5, No. 1, 71-4 (Jan., 1961).
A value of the solar parallax, 8".8021 ± 0".00006, was derived ...om the Venus radar experiment carried out at Millstone Hill, ...assachusetts, in February 1958 [Science (USA), Vol. 129, 751 ...959)]. In a similar experiment in August and September 1959, no ...finite Venusian echoes were obtained; reasons for the failure ...e at present unknown. H.Rishbeth

10396 PECULIARITIES OF THE RADIO RADIATION OF NGC 4486. Yu.N.Pariiskii.
Dokl. Akad. Nauk SSSR, Vol. 137, No. 1, 49-50 (March 1, 1961). In Russian.
Observations made in Feb. 1960 at wavelength 8.7 cm confirm that the distribution of radio brightness of the Virgo A source depends essentially on the wavelength: the angular dimensions of the central source are at least 5 times smaller (~ 1') at centimetre than at metre wavelengths. The coordinates of the centre of gravity of the radio source are found to be 45" ± 15" to the west of the centre of the spheroidal galaxy, on the side of the jet. Polarization considerations indicate that the mass of ionized gas in the jet is $\geq 10^4 M_\odot$ [English translation in: Soviet Physics—Doklady (USA)]. G.A.Chisnall

10397 AMPLITUDE AND ANGULAR SCINTILLATIONS OF THE RADIO SOURCE CYGNUS-A OBSERVED AT BOULDER, COLORADO. R.S.Lawrence, J.L.Jespersen and R.C.Lamb.
J. Res. Nat. Bur. Stand. (USA), Vol. 65D, No. 4, 333-50 (July-Aug., 1961).
Variations in the apparent flux and position of the radio source Cygnus-A were recorded at 53 and 108 Mc/s using a two-element, phase-sweeping interferometer located at Boulder, Colorado. An ionospheric sounder operating at Ellsworth, Nebraska, provided, for a few hours each day, simultaneous vertical-incidence measurements on the ionosphere at its intersection with the line of sight from Boulder to the radio star. Amplitude scintillations observed at Boulder over a twelve-month period are compared with ionograms taken at Ellsworth. Positive correlation is found between amplitude scintillations and spread F, while no significant correlation is found with sporadic E. Detailed analysis of the scintillations indicates that the probability distribution of the amplitude can be represented by the Rice probability distribution function. The zenith-angle dependence of the amplitude scintillations does not agree with a theory based upon isotropic ionospheric inhomogeneities. The root-mean-square value of angular scintillations is proportional to the square of the wavelength, in accord with a theory of diffraction by ionospheric irregularities. Comparison of angular scintillations with amplitude scintillations indicates that, for elevation angles of 15° to 50°, the region of the ionosphere responsible for scintillation lies near the border between the Fresnel and Fraunhofer diffraction regions for both frequencies. Slow, irregular angular variations are commonly observed in the daytime at both frequencies. These variations are attributed to lens-like ionospheric irregularities having dimensions as large as 200 kilometers.

10398 SOME ATTEMPTS TO DETECT LINEAR POLARIZATION OF GALACTIC RADIO EMISSION FROM THE SPUR AT $l^{II} = 30°$. I.I.K.Pauliny-Toth, J.E.Baldwin and J.R.Shakeshaft.
Monthly Not. Roy. Astron. Soc. (GB), Vol. 122, No. 4, 279-83 (1961).
Experiments were carried out in an attempt to detect linearly polarized radiation from the galactic spur at $l^{II} = 30°$. Five observational methods are discussed and the results of experiments using these methods are given. The frequencies used were 160, 178, and 408 Mc/s and the region of observation covered the more intense parts of the spur. All the experiments agree in fixing a low upper limit of a few per cent on linearly polarized radiation from the spur.

10399 RADIO EMISSION FROM NORMAL GALAXIES. P.R.R.Leslie.
Observatory (GB), Vol. 80, 216-19 (Dec., 1960).
A search was made for radio sources in the position of 35 optically bright galaxies away from the galactic plane. Sources were observed in the position of 11 of these and upper limits of flux density are given for the others. Values of Mpg against Mr are plotted, and (Mr-Mpg) values range mostly from −1 to +2. H.J.A.Chivers

Space Research

10400 THE IMPACT OF LUNIK II ON THE MOON. P.Moore.
J. Brit. Astron. Assoc., Vol. 71, No. 5, 218 (1961).

10401 ON TWO METHODS OF BROWN AND SHOOK. H.Jeffreys.
Monthly Not. Roy. Astron. Soc. (GB), Vol. 122, No. 4, 335-8 (1961).
A method given by Brown and Shook (1933) for the elimination of short-period terms from the disturbing function is essentially an extension of one given by von Zeipel (1916). A slight further extension is given here. It is shown that the method of Brouwer

for the motion of artificial satellites is a case of that of Brown and Shook. Another method of Brown and Shook uses the orbital true longitude as independent variable. The motion of an artificial satellite appeared to provide a particularly suitable case for the application of this method, but on trial it proved to be extremely laborious. Some suggestions are offered with regard to sign conventions in Hamiltonian theory.

10402 OBSERVATIONS OF SATELLITE 1960 ζ 1, AND A COMPARISON WITH SATELLITE 1958 δ 1. C.R.Faulkner.
Nature (GB), Vol. 190, 520-1 (May 6, 1961).

Details are given of measurements of the flash period of satellite 1960 ζ 1 (Midas 2) made at Elizabeth, S. Australia, and a comparison of the rate of decrease of angular momentum of spin of this satellite with that of 1958 δ 1 (Sputnik 3 rocket).

G.M.Brown

PHYSICS

GENERAL

10403 CITATIONS FOR DISTINGUISHED SERVICE. L.O.Olsen.
Amer. J. Phys., Vol. 29, No. 8, 476-7 (Aug., 1961).

The American Association of Physics Teachers has annually cited various of its members for distinguished service to the teaching of physics. The four citations presented in 1961, are quoted.

10404 ON THE ROLES OF EXPERIMENT AND THEORY IN COGNITION (COMMENT ON THE ARTICLE BY MAX BORN). S.Suvorov.
Uspekhi fiz. Nauk (USSR), Vol. 66, No. 3, 375-90 (Nov., 1958). In Russian.

This article is mainly concerned with a discussion of Born's position that scientific theory rests wholly on experiment and not at all on a prior knowledge or concepts. A final section discusses the notion that physics can be built up from operators based on the, possibly idealized, operations of measurement, a suggestion that both Born and the author reject.

[As might be expected, the article contains many controversial remarks. The statement that Eddington's work on the fundamental constants is "widely accepted" is obviously untrue, since only a few people understand it. In the abstractor's view, it is a great pity that no mention is made of the processes by which theories are developed, because no theory ever reaches a completely final form. There can be no question that analogy, intuition, mysticism and a priori concepts play a great part in the development of theories. When they are developed, it may be that they can be presented in a way that avoids them]. [English translation in: Soviet Physics—Uspekhi, (USA), Vol. 1(66), No. 2, 179-90 (Nov.-Dec., 1958)].

H.N.V.Temperley

10405 GRAPHICAL REPRESENTATION FOR UNIT SYSTEMS. E.U.Condon.
Amer. J. Phys., Vol. 29, No. 8, 487-91 (Aug. , 1961).

Presents some ideas concerning physical systems of units, and a graphical representation of them, which has been found useful in teaching the subject.

10406 LAWS OF PHYSICAL LAWS. M.Bunge.
Amer. J. Phys., Vol. 29, No. 8, 518-29 (Aug., 1961).

Statements about scientific laws, called metanomological statements, are examined. The following kinds are distinguished and illustrated: (1) factual metanomological statements like "Newton's laws of motion are invariant under time reversal"; (2) normative metanomological statements such as "The equations of motion are not to depend on any frame of reference"; and (3) methodological metanomological statements like "Law statements should not include egocentric particulars such as 'now'." It is claimed that metanomological statements are not laws of nature but a subclass of metastatements, and that they are justified in various ways, since some of them are analytic, others are synthetic, and finally others are in the nature of norms or rules. The status of wide-scope physical principles, such as those of covariance, gauge invariance, and parity, is studied in the light of the above distinctions. In particular, some metascientific problems posed by parity nonconservation and by the combined parity (CTP) theorem are dealt with. Finally, the occurrence of important ought-statements in the language of science is employed against the dichotomy between science and ethics.

10407 OPTIMAL MEASURING APPARATUS. M.M.Yanase.
Phys. Rev. (USA), Vol. 123, No. 2, 666-8 (July 15, 1961).

An upper limit for the accuracy of the measurement of a simple quantity which does not commute with a conserved quantity is obtained in terms of the "size" of the apparatus. The "size" of the apparatus is defined as the mean square value $\hbar^2M^2$ of the conserved quantity for the apparatus which is, in the example chosen, the z component of the angular momentum. The measured quantity is the projection of a spin in a perpendicular direction. It is found that the probability of an unsuccessful measurement is at least $1/8M^2$.

GRAVITATION . RELATIVITY

COUPLING OF THE GRAVITATIONAL FIELD WITH A DIRAC PARTICLE. See Abstr. 9721

10408 RELATIVISTIC OSCILLATOR WITH NATURAL FORCING FUNCTIONS. I.U.Ojalvo.
Amer. J. Phys., Vol. 29, No. 8, 508-9 (Aug., 1961).

The free vibrations of a point on a linear spring with mass determined by the special theory of relativity is extended to the case of forced oscillations. Significant dimensionless parameters of the phenomena are introduced and frequency response curves, which resemble those for a constant mass on a soft spring, are plotted. The method of solution, which makes use of "natural" forcing functions to furnish the excitation, is justified.

10409 PROPER TIME, APPARENT TIME, AND FORMAL TIME IN THE TWIN PARADOX. V.Hlavaty.
J. Math. Mech. (USA), Vol. 9, 733-44 (1960).

The author considers the purely geometrical aspect of the clock paradox. The apparent time $\{\tau_i\}_{\tau_j}$ of observer P_i as observed by observer P_j, where i, j = 1, 2 and i = j, or i ≠ j, obeys the equation

$$\{\tau_i\}_{\tau_i} = \{\tau_j\}_{\tau_i} \cosh \omega,$$

where the relative velocity $V = \tanh \omega$. The author also introduces the formal time $[E]_i$ of an event E, which he defines as the proper time of the segment O_iE, where O_i is the origin of the inertial frame of reference in which P_i is at rest. If P_j changes his inertial frame of reference, and E_j^i denotes the event on the world-line of P_i which is simultaneous with E_j [an event on the world-line of P_j] from the point of view of P_i, then

$$\frac{[E_i^j]_j}{[E_i]_j} = \frac{[E_j^i]_i}{[E_j]_i} = \cosh \Omega(t_j),$$

where t_j is the time-coordinate of $E_i = E_j^i$ in the inertial frame of reference of P_j, and Ω is the appropriate value of ω. From purely geometrical data alone, P_i cannot decide whether he changes his inertial frame of reference or not. Each observer regards the apparent time of the other as smaller than his own by the same factor $1/\cosh\omega$. But clocks which show formal time will synchronize when the observers meet again. The author stresses that he is considering only geometrical invariants without attempting to identify them with either physical or biological concepts.

Mathematical Reviews (G.J.Whitrow)

10410 THE RELATIVISTIC THEORY OF THE FRESNEL DRAG COEFFICIENT. P.T.Landsberg.
Nature (GB), Vol. 189, 654 (Feb. 25, 1961).

The dispersion term in the relativistic expression for the

nel drag coefficient depends on whether one is considering
· flowing in a tube or a moving block of glass. A simple argu-
is given which leads to these two formulae as special cases.
nents are made on the relationship between them.
P.T.Landsberg

10411 EXPERIMENTAL VERIFICATION OF RELATIVITY USING NUCLEAR RESONANCE ABSORPTION.
Krause and G.Lüders.
Naturwissenschaften (Germany), Vol. 48, No. 2, 34-6 (1961).
In German.
Elementary survey, including simple quasi-Newtonian derivation
ed-shift and some details of the Pound–Rebka experiment
tr. 36 and 10570 of 1960). F.A.E.Pirani

10412 A RELATIVISTIC MODEL FOR A SHELL OF FLOWING RADIATION IN A HOMOGENEOUS UNIVERSE.
Vaidya and K.B.Shah.
gr. theor. Phys. (Japan), Vol. 24, No. 1, 111-25 (July, 1960).
Rigorous solutions of Einstein's field equations of general
tivity are presented. They are found to represent the gravita-
al field within a shell of radiation flowing outwards in a homo-
eous universe. These models suggest that the effect of complete
version of matter into radiation appears to decrease the curva-
of the universe.

10413 ON THE CONCEPT OF REGRADUATION IN GENERAL RELATIVITY. H.Nariai and Y.Ueno.
Gen. theor. Phys. (Japan), Vol. 24, No. 3, 593-613 (Sept., 1960).
An attempt is made to develop a theory of regraduation of
les and clocks in the general theory of relativity as one of
chodological approaches to examine the interrelationship between
ce-time and gravitation. The relation between the orthodox
malism of general relativity and its reinterpretations based on
flat space-time is made clear, and the problem of a particular
onformal") regraduation is investigated in detail.

10414 ON SOME PECULIAR ROLE OF THE COSMOLOGICAL CONSTANT IN THE GENERAL THEORY OF RELATIVITY AND IN THE SCHRÖDINGER THEORY OF NON-SYMMETRIC FIELD. H.Nariai and Y.Ueno.
Progr. theor. Phys. (Japan), Vol. 24, No. 6, 1149-65 (Dec., 1960).
The role of the so-called cosmological constant Λ is investi-
ed from the two alternative standpoints of the general theory
relativity and the Schrödinger theory of non-symmetric field.
s shown that, in spite of the rather drastically different
aracter of the latter theory from the former, there exists a
uliar solution whose existence is assured by the role of Λ in
stion, and whose physical meaning is equivalent to that of
rtotti's solution in general relativity.

10415 ON THE INTERPRETATION OF THE EINSTEIN–SCHRÖDINGER UNIFIED FIELD THEORY.
W.Sciama.
math. Phys. (USA), Vol. 2, No. 4, 472-7 (July-Aug., 1961).
Vierbeins are used to analyse the Einstein–Schrodinger
ified field theory, in both its real non-symmetric and complex
rmitian versions. It appears that the skew-symmetric part of
real affine connection is related to spin rather than to electro-
gnetism. In its complex form the theory does appear to describe
electromagnetic field, since the vierbein analysis shows that
uge transformations arise in a natural way (the spin is then
lated to the skew-Hermitian part of the affine connection). The
sulting identification of the electromagnetic field tensor implies
at Einstein's choice of Lagrangian is physically unsatisfactory
d an alternative Lagrangian is proposed. Although the electro-
agnetic field is thus geometrized, neither Lagrangian represents
unification of electromagnetism and gravitation.

QUANTUM THEORY

(Applications of quantum theory to elementary particles and nuclei are included under Nuclear Field Theory)

10416 UNITARY INTERPRETATION OF QUANTUM THEORY. A.Landé.
Amer. J. Phys., Vol. 29, No. 8, 503-7 (Aug., 1961).
This Anti-Copenhagen interpretation [cf. Hanson (Abstr. 1034 of 1959)] submits that the doctrine of an inherent double nature of matter (and of light) is a most uneconomical hypothesis which would never have been proposed (except for heuristic purposes) had it not been for an oversight of the mechanical particle theory of diffraction by Duane (1923), later incorporated into the quantum mechanics of 1926 in Born's unitary statistical interpretation of wavelike phenomena. Bohr's indeterminacy view comes from a verbal translation of a legitimate wave feature; it is contrasted to the uncertainty of prediction of exact results. The latter is supported by the experiment, the former is not, so that various "epistemological lessons" drawn from Bohr's view stand on brittle ground, which can hardly be reinforced by pointing to the transformation from the first to the second quantization, i.e., from one to another form of a complete and unitary theory. The simple quantum rules of the particle theory (first quantization) can be reduced to general postulates of symmetry and invariance.

10417 STRICT LOCALIZATION IN QUANTUM FIELD THEORY. J.M.Knight.
J. math. Phys. (USA), Vol. 2, No. 4, 459-71 (July-Aug., 1961).
A definition of strict localization of states in quantum field theory is presented. This definition is based on considering products of field operators as the primary measurable quantities of the theory. An example of a localized state is given, showing that such a state arises when a free field interacts with an external current that is limited to a bounded region of space–time. It is shown by means of a graphical technique that a state having a finite number of particles cannot satisfy the definition of localization. A simple representation of localized states is investigated, and arguments are given to support its generality and uniqueness.

10418 FOUNDATIONS OF QUANTUM THEORY AND COMPLEMENTARITY. L.Rosenfeld.
Nature (GB), Vol. 190, 384-8 (April 29, 1961).
Lecture explaining the connection between uncertainty and the wave-particle complementarity, and comparing its logical structure with that of the microscopic–macroscopic complementarity in statistical thermodynamics. The influence of the fact that the observer is human is also examined. J.Hawgood

10419 ON THE POSSIBLE GENERALIZATIONS OF PLANCK'S LAW. M.Strauss.
Nuovo Cimento (Italy), Vol. 19, No. 3, 594-6 (Feb. 1, 1961).
A possible approach to generalizing quantum theory by the introduction of a quantum of length is discussed in relation to the necessary changes in Planck's law, which must reduce to the conventional form when the fundamental length is sufficiently small. R.F.Peierls

10420 MATHEMATICAL FOUNDATION OF THE QUANTUM THEORY OF FREE FIELDS. H.Wakita.
Progr theor. Phys. (Japan), Vol. 24, No. 3, 555-68 (Sept., 1960).
The assumption is made that there is a quantum mechanical system at each point of the space-time, and on this assumption one can precisely construct the quantum theory of free fields. This theory is mathematically meaningful, and contains a theory which is completely equivalent to the usual one from the physical standpoint. The physical meaning and the mathematical contents of field operators are clarified.

QUANTUM THEORY OF INTERFERENCE EFFECTS IN THE MIXING OF LIGHT FROM PHASE-INDEPENDENT SOURCES.
See Abstr. 10598

10421 GENERAL LORENTZ TRANSFORMATIONS OF THE DIRAC EQUATION. E.Landhäusser.
Z. Phys. (Germany), Vol. 162, No. 5, 438-47 (1961). In German.
The covariance of the Dirac equation implies the existence of a matrix Λ which carries out the appropriate spinor transformations. Various properties of the Λ matrix, including explicit representations, are concisely derived. T.Erber

10422 ON THE QUANTIZATION OF PHYSICAL SPACE-TIME OPERATORS. I.Watanabe.
Progr. theor. Phys. (Japan), Vol. 24, No. 3, 465-82 (Sept., 1960).

In order to find a clue to extending the conventional field theory in a consistent way, a physical interpretation of the Dirac–Bergmann field theory [Canadian Journal of Mathematics, Vol. 2, 129 (1950)] is proposed from the point of view of the uncertainty principle. The physical space-time operators introduced by them are connected with the measurement of the position. Further a new formulation of the auxiliary condition, which is the direct consequence of the quantization of the physical space-time operators, is constructed, and then the consistency and the detailed structure of the formalism are made clear.

10423 INTERNAL QUANTUM STATES OF HYPERSPHERICAL (NAKANO) RELATIVISTIC ROTATORS.
D.Bohm, P.Hillion and J.P.Vigier.
Progr. theor. Phys. (Japan), Vol. 24, No. 4, 761-82 (Oct., 1960).

If one quantizes by conventional methods the classical internal motion of the hyperspherical (Nakano) relativistic rotator, the relativistic Hamiltonian splits into the sum of two complex conjugate spherical complex three-dimensional rotators. The corresponding excited "levels" also split into fine structure states, each "level" being naturally associated to a vector space irreducible under complex transformations isomorphic to the full Lorentz group. It finally turns out that every state is characterized by a set of quantum numbers with which we can classify typical families of rotator levels.

10424 LAGRANGIAN FORMALISM IN RELATIVISTIC DYNAMICS. G.Kalman.
Phys. Rev. (USA), Vol. 123, No. 1, 384-90 (July 1, 1961).

A covariant Lagrangian formalism is put forward with an explicit variation of the proper time in the action functional. This approach conforms with the geometrical interpretation in space-time. A general equation of motion is derived, which is not identical with the Euler–Lagrange equation. Momentum and mass are unambiguously defined through the requirement of translational invariance. The rest mass is constant in the special case of electromagnetic field only. A conservation law for the combination of the momentum and the energy momentum-tensor of the free field is derived. No satisfactory Hamiltonian formalism can be established within the framework of the formalism.

STATISTICAL MECHANICS TRANSFER PROCESSES

10425 VON NEUMANN'S HIDDEN-PARAMETER PROOF. J.Albertson.
Amer. J. Phys., Vol. 29, No. 8, 478-84 (Aug., 1961).

Because the mathematical form of the proof is not well known, its scope has sometimes been unjustifiably narrowed by commentators. The proof is here reproduced in the more familiar Dirac calculus and its precise import made clearer. In particular, it is emphasized that the proof proceeds independently of both the basic statistical assumption of quantum mechanics: $\langle R\rangle_{av} = \langle\phi|R|\phi\rangle$, and the extension of this assumption to mixtures: $\langle R\rangle_{av} = \mathrm{Tr}(UR)$, where $U = \Sigma_n|\phi_n\rangle w_n\langle\phi_n|$. Mention is also made of some recent criticisms of the von Neumann proof.

10426 SOME CLUSTER SIZE AND PERCOLATION PROBLEMS. M.E.Fisher and J.W.Essam.
J. math. Phys. (USA), Vol. 2, No. 4, 609-19 (July-Aug., 1961).

The problem of cluster size distribution and percolation on a regular lattice or graph of bonds and sites is reviewed and its applications to dilute ferromagnetism, polymer gelation, etc. briefly discussed. The cluster size and percolation problems are then solved exactly for Bethe lattices (infinite homogeneous Cayley trees) and for a wide class of pseudolattices derived by replacing the bonds and/or sites of a Bethe lattice by arbitrary finite subgraphs. Explicit expressions are given for the critical probability (density), for the mean cluster size, and for the density of infinite clusters. The nature of the critical anomalies is shown to be the same for all lattices discussed; in particular, the density of infinite clusters vanishes as $R(p) \cong C(p - p_c)$ $(p \geq p_c)$.

10427 CRITICAL PROBABILITIES FOR CLUSTER SIZE AND PERCOLATION PROBLEMS. M.E.Fisher.
J. math. Phys. (USA), Vol. 2, No. 4, 620-7 (July-Aug., 1961).

When particles occupy the sites or bonds of a lattice at random with probability p, there is a critical probability p_c above which an infinite connected cluster of particles forms. Rigorous bounds and inequalities are obtained for p_c on a variety of lattices and compared briefly with previous numerical estimates. In particular by extending Harris' work, it is proved that $p_c(s,L_2) \geq \frac{1}{2}$ for the site problem on a plane lattice L_2 (without crossing bonds), while for the bond problem $p_c(b,L_2) + p_c(b,L_2^D) \geq 1$ where L_2^D is the dual lattice to L_2. Simple arguments demonstrate that the bond problem is a special case of the site problem and that the critical probabilities for the bond problem on the plane square and triangular lattice cannot exceed those for the corresponding site problems.

10428 TWO MODELS OF BROWNIAN MOTION. N.D.Mermin.
Amer. J. Phys., Vol. 29, No. 8, 510-17 (Aug., 1961).

Two simple models are presented. They are used to examine the circumstances under which the detailed velocity dependence of collisions may be adequately represented by a continuous frictional damping. The differences between the equilibrium velocity distributions predicted by a damping approximation and an exact treatment are discussed.

10429 ON THE THEORY OF CONDENSATION. N.Saitô.
J. chem. Phys. (USA), Vol. 35, No. 1, 232-42 (July, 1961).

A calculation based on the Bragg–Williams approximation in lattice gases is presented, which shows a connection between the Yang–Lee and Mayer theories of condensation through an analogy with image charges in a two-dimensional electrostatic problem. The main features of this calculation are presumed to be retained in an exact treatment of lattice gases and real gases. A determination of the singularities of Mayer's series is made by making use of the results of recent investigations of cluster integrals by the approximation of the diagram method. It is concluded to be very probable that Mayer's theory cannot locate the condensation point but determines instead the supersaturation limit. Further, there is no "Derby hat" region near the critical point.

10430 EFFECT OF INTERMOLECULAR FORCES ON MACROMOLECULAR CONFIGURATIONAL CHANGES AND ON OTHER ISOMERIC EQUILIBRIA. T.L.Hill.
J. chem. Phys. (USA), Vol. 35, No. 1, 303-5 (July, 1961).

The effect of intermolecular forces on isomeric equilibria (configurational changes in macromolecules are a special case) is investigated. The term corresponding to the second virial coefficient is derived but the method can easily be extended to higher terms. A significant and measureable effect is predicted for (a) isomeric equilibria involving atoms or small molecules or (b) configurational changes in macromolecules at a first-order phase transition or critical point. A negligible effect is predicted for configurational changes in macromolecules otherwise. These conclusions apply to "proper" thermodynamic variables only; the end-to-end length r of a random coil is excluded.

10431 THE PRESENT STATE OF ERGODIC THEORY. I.E.Farquhar.
Nature (GB), Vol. 190, 17-18 (April 1, 1961).

This paper offers a brief survey of Ergodic Theory in classic and quantum statistical mechanics, with special reference to developments during the last 10 years. P.T.Landsberg

10432 DETERMINATION OF POTENTIAL PARAMETERS FROM THERMAL DIFFUSION. B.N.Srivastava.
Phys. of Fluids (USA), Vol. 4, No. 4, 526 (April, 1961).

A discussion of the merits of various methods of estimating interactions between unlike atoms from thermal diffusion data. 6 references. H.N.V.Temperley

10433 CALCULATION OF THE VIBRATIONAL SUM OVER STATES OF DEGENERATE ANHARMONIC OSCILLATORS BY USING THE MELLIN TRANSFORMATION. G.Vojta.
Ann. Phys. (Germany), Vol. 7, No. 7-8, 397-402 (1961). In Germa

A method of summation of series of a certain type is applied to an assembly of oscillators whose total energy is a quadratic function of the oscillator quantum numbers. The sum over states is obtained in a very compact closed form. H.N.V.Temperley

10434 ENTROPY OF LOCALIZATION AND EXTENSION IN A QUANTUM MECHANICAL SYSTEM.
Bochvar, I.V.Stanevich and A.L.Chistakhov.
. Akad. Nauk SSSR, Vol. 135, No. 5, 1095-6 (Dec. 11, 1960).
ussian.
For abstract, see Abstr. 4272 of 1961. [English translation in: et Physics—Doklady (USA), Vol. 5, No. 6, 1271-2 (May-June,)].

10435 QUANTUM STATISTICAL MECHANICS OF ISOTOPE EFFECTS. I.Oppenheim and A.S.Friedman.
hem. Phys. (USA), Vol. 35, No. 1, 35-40 (July, 1961).
Expansions in powers of Planck's constant are utilized in a ussion of isotope effects on the thermodynamic properties of l systems. Theoretical calculations of the differences in the ations of state of the hydrogen isotopes and of the helium isotopes presented and comparison with experimental results is made. eement between theory and experiment is excellent.

10436 THE THEORY OF SUPERFLUIDITY OF A FERMI SYSTEM WITH ISOTOPIC SPIN.
V.Tsekhmistrenko.
rayin. fiz. Zh. (USSR), Vol. 4, No. 1, 39-45 (1959). In Ukrainian.
Bogolyubov's method of distribution functions is applied to culate the energy of the ground state and the energy of element- excitations of nuclear matter with an arbitrary central inter- tion among the nucleons, and with the condition that the number protons differs from the number of neutrons. Regardless of smallness of the coupling constant, the interaction between the utrons and protons proves ineffective for superfluid states.

10437 THE RELATION OF THE STATISTICAL VARIATIONAL PRINCIPLE TO THE METHOD OF PARTIAL MMATION OF DIAGRAMS IN THERMODYNAMIC PERTURB- TION THEORY IN THE MODIFIED FORMULATION OF THE OBLEM OF A NON-IDEAL BOSE—EINSTEIN SYSTEM.
V.Tolmachev.
kl. Akad. Nauk SSSR, Vol. 134, No. 6, 1324-7 (Oct. 21, 1960).
Russian.
For abstract, see Abstr. 5226 of 1961. [English translation in: viet Physics—Doklady (USA), Vol. 5, No. 5, 984-8 (March-April, 61)].

10438 CONSTRUCTION OF ASYMPTOTIC EXPANSIONS FOR WEAK INTERACTION FROM A FORMAL THERMO- NAMIC PERTURBATION WITH A MODIFIED FORMULATION OF IE PROBLEM THEORY OF A NON-IDEAL BOSE—EINSTEIN STEM. V.V.Tolmachev.
kl. Akad. Nauk SSSR, Vol. 135, No. 1, 41-4 (Nov. 1, 1960).
Russian.
For abstract, see Abstr. 5227 of 1961. [English translation in: viet Physics—Doklady (USA), Vol. 5, No. 6, 1190-3 (May-June, 61)].

10439 TEMPERATURE-DEPENDENT ELEMENTARY EXCITATIONS IN A NON-IDEAL BOSE--EINSTEIN STEM. V.V.Tolmachev.
okl. Akad. Nauk SSSR, Vol. 135, No. 4, 825-8 (Dec. 1, 1960).
Russian.
For abstract, see Abstr. 5228 of 1961. [English translation in: viet Physics—Doklady (USA), Vol. 5, No. 6, 1267-70 (May-June, 961)].

10440 STATISTICAL THEORY OF A MIXED ION-DIPOLE SYSTEM OF INTERACTING PARTICLES.
R.Yukhnovskii.
okl. Akad. Nauk SSSR, Vol. 136, No. 6, 1317-20 (Feb. 21, 1961).
Russian.
The free energy of a system containing several types of harged particles and one type of dipole is expressed in terms of ollective coordinates. [English translation in: Soviet Physics — oklady (USA), Vol. 6, No. 2, 150-2 (Aug., 1961)]. D.W.L.Sprung

10441 LOCAL PROPERTIES IN NON-EQUILIBRIUM SYSTEMS.
J.M.Blatt.
rogr. theor. Phys. (Japan), Vol. 24, No. 4, 741-54 (Oct., 1960).
The development of a satisfactory statistical mechanics for non- quilibrium states has been retarded by the difficulty of making a atisfactory definition of "local temperature", that is, a definition hich does not depend on the very restrictive assumption of local quilibrium. The author first defines, for any subvolume ΔV of the ystem, the "local statistical operator" $W(\Delta V)$, which can be educed directly from the statistical operator (density matrix) U of the system as a whole. Next, a local entropy $S(\Delta V)$ and a local energy $E(\Delta V)$ are defined. Finally, the author introduces a new requirement for the macroscopic independent variables which define the macroscopic state of the system: such variables must be directly deducible from a knowledge of the present state (density matrix) of the system, without reference to its future time development, i.e. without reference to its Hamiltonian H. Of any pair of thermodynamically conjugate variables, at most one is permissible in the light of this requirement. In particular, volume, particle numbers, and entropy are permissible macroscopic independent variables; pressure, chemical potential, and temperature are not. These latter are permissible as dependent variables, only, unless the system happens to be in equilibrium.

10442 PERSISTENCE OF STABILITY IN LAGRANGIAN SYSTEMS. F.E.Low.
Phys. of Fluids (USA), Vol. 4, No. 7, 842-6 (July, 1961).
It is shown for a large class of Lagrangian systems that a steady-state configuration of the system which is linearly stable remains so under a small variation of the steady state, to all orders of perturbation theory in the variation. The principle is applied to two special systems: an incompressible ideal fluid, and a gas of charged particles interacting through their average fields.

10443 CLUSTER EXPANSION TECHNIQUE IN THE MANY-FERMION SYSTEMS. K.Nakamura.
Progr. theor. Phys. (Japan), Vol. 24, No. 6, 1195-1214 (Dec., 1960).
A new cluster expansion technique is developed for the calculation of the energy expectation value of many-fermion systems with singular potentials. The wave-function is of the form

$$\Psi = \prod_{(i,j)} f(r_{ij}) \sum_{P} (-1)^{P} P\{\chi(1,2)\chi(3,4)\cdots\cdots\chi(2N-1,\ 2N)\}.$$

which, in a special case, coincides with Jastrow's wave-function (Abstr. 6762 of 1955). The formula for the energy expectation value is written in terms of the complex cluster integrals. The method introduced in the derivation of this formula has an analogy to the classical cluster expansion method in the theory of an imperfect classical multicomponent gas.

10444 ON HUGENHOLTZ— PINES' THEORY ABOUT GROUND STATE ENERGY OF INTERACTING BOSONS.
S.Misawa.
Progr. theor. Phys. (Japan), Vol. 24, No. 6, 1224-30 (Dec., 1960).
Hugenholtz and Pines (Abstr 2132 of 1960) developed a new method of evaluating the ground-state energy of a system of interacting bosons, the merit of which consists in the elimination of the zero-momentum state and accordingly the applicability of the linked cluster expansion. Their theory, however, does not give correct results because of the undue treatment of the zero-momentum state; this is proved in a simple example. The result of the usual Rayleigh—Schrödinger perturbation method is compared with that obtained according to Hugenholtz—Pines theory up to third order in the coupling parameter of the ground-state energy, and it is found that the latter does not agree with the former. [In an Erratum (ibid., Vol. 25, No. 2, 303, Feb., 1961), an error is pointed out in one of the equations; the Hugenholtz—Pines method is then found to give the correct result.]

10445 ON THE KINETIC THEORY OF DENSE FLUIDS. VI. SINGLET DISTRIBUTION FUNCTION FOR RIGID SPHERES WITH AN ATTRACTIVE POTENTIAL.
S.A.Rice and A.R.Allnatt.
J. chem. Phys. (USA), Vol. 34, No. 6, 2144-55 (June, 1961).
A new integro-differential equation for the singlet distribution function in a model dense fluid is derived and solved. In the model considered, the pair interaction potential is represented as a rigid core plus a soft attraction. Interactions between two rigid cores are handled as in the theory of the dense rigid-sphere fluid, while interactions between the soft attractions are handled, following Kirkwood, in the Fokker—Planck approximation. The use of coarse graining in time to provide a time scale permitting the above separation, the relaxation in momentum space, the kinetic flux vectors, and the physical basis of the analysis are all discussed.

10446 ON THE KINETIC THEORY OF DENSE FLUIDS. VII. THE DOUBLET DISTRIBUTION FUNCTION FOR RIGID SPHERES WITH AN ATTRACTIVE POTENTIAL.
A.R.Allnatt and S.A.Rice.
J. chem. Phys. (USA), Vol. 34, No. 6, 2156-65 (June, 1961).
A new integro-differential equation for the doublet distribution

function of a model dense fluid is derived and solved. In this model the intermolecular pair potential is represented as a rigid core plus an attraction. Interactions involving rigid cores are handled as in the theory of the dense rigid-sphere fluid and attractive interactions are handled as in the Fokker—Planck theory. The resultant doublet distribution function is compared with the singlet distribution function calculation calculated for the same model.

10447 EXCITATION SPECTRUM IN MANY-BOSON SYSTEMS. F.Takano.
Phys. Rev. (USA), Vol. 123, No. 2, 699-705 (July 15, 1961).

When only two-body correlations are fully taken into account, there appears an energy gap in the excitation spectrum for many-boson systems as shown by Girardeau and Arnowitt (Abstr. 5375 of 1959) and confirmed by Wentzel (Abstr. 75 of 1961). This energy gap is shown to disappear and the spectrum to become phonon-like again and proportional to the momentum for small momentum, if one constructs the eigenmodes of excitations (collective excitations), taking into consideration appropriate higher-order terms.

MOBILITY OF IONS IN A SYSTEM OF INTERACTING BOSE PARTICLES. See Abstr. 10672

10448 INFLUENCE OF THE TRANSFER OF HEAT UPON THE TRANSFER OF MASS IN THE CASE OF THE RECTIFICATION OF BINARY MIXTURES. E.Ruckenstein.
C. R. Acad. Sci. (France), Vol. 252, No. 15, 2223-5 (April 10, 1961). In French.

A system of equations is submitted which enables the calculation of a rectification column. It is based on the influence of heat transfer on the condensation-vaporization process, and affords a partial explanation of the discrepancy between theory and practice.
H.H.Hodgson

10449 A VARIATION PRINCIPLE IN THE THEORY OF TRANSPORT PHENOMENA. H.Nakano.
Progr. theor. Phys. (Japan), Vol. 23, No. 1, 180-2 (Jan., 1960).

Continuing the work of a former paper (Abstr. 7019 of 1961), a variational method of solving the Schrödinger equation for the density matrix is applied to the calculation of thermoelectric coefficients. The variational principle used is that, suitably defined, the rate of production of entropy is an extremum.
H.N.V.Temperley

10450 A VARIATION PRINCIPLE FOR CALCULATING GENERAL SUSCEPTIBILITY TENSORS. H.Nakano.
Progr. theor. Phys. (Japan), Vol. 23, No. 1, 182-3 (Jan., 1960).

See preceding abstract. A variational principle for calculating the complex electric or magnetic susceptibility from the Schrödinger equation for the density matrix is suggested and is tested on the one-body problem.
H.N.V.Temperley

10451 DIFFUSION OF RADIATION IN A MEDIUM WITH A SPECULARLY REFLECTING BOUNDARY. V.V.Sobolev.
Dokl. Akad. Nauk SSSR, Vol. 136, No. 3, 571-4 (Jan. 21, 1961). In Russian.

For abstract, see Abstr. 5237 of 1961. [English translation in: Soviet Physics—Doklady (USA), Vol. 6, No. 1, 21-3 (July, 1961)].

10452 CAUCHY'S PROBLEM FOR THE EQUATION WITH MANY SPATIAL VARIABLES, FOR NON-STATIONARY FILTRATION OF A GAS. E.S.Sabinina.
Dokl. Akad. Nauk. SSSR, Vol. 136, No. 5, 1034-7 (Feb. 11, 1961). In Russian.

The subject of this paper is the diffusion equation in multi-dimensional coordinate space. Theorems are established from which the existence of unique solutions follows which satisfy arbitrary initial conditions. [English translation in: Soviet Physics — Doklady (USA)].
R.Eisenschitz

10453 SELF-DIFFUSION AND VELOCITY CORRELATION. D.C.Douglass.
J. chem. Phys. (USA), Vol. 35, No. 1, 81-90 (July, 1961).

Approximate expressions for the self-diffusion coefficients of spherical molecules in solid, liquid, and gas phases are obtained from the relation

$$D = (kT/m)\int_0^\infty \rho(s)ds,$$

where D is the diffusion coefficient and $\rho(s)$ is the velocity correlation function of the spherical molecules. The correlation function is approximated by the function $\cos\alpha\delta s/\cosh\alpha s$ and the parameters α and δ are expressed in terms of molecular properties for liquids and gases. The approximate diffusion coefficient is found to obey an Arrhenius relation in the solid phase and a Sutherland equation for the gas phase. The results of a crude calculation of the self-diffusion coefficient for liquid neopentane are within a factor of two of the experimental diffusion coefficients. The temperature coefficient of the calculated diffusion coefficients is also within a factor of two of the observed temperature coefficient.

10454 ON THE PRINCIPLE OF INVARIANCE IN A SEMI-INFINITE INHOMOGENEOUS ATMOSPHERE. S.Uen
Progr. theor. Phys. (Japan), Vol. 24, No. 4, 734-40 (Oct., 1960).

With aid of an extension of Chandrasekhar's invariance meth (Abstr. 1418, 2398 of 1947) and the principle of invariant imbeddi stated by Bellman and Kalaba (Abstr. 6673 of 1958) respectively, the author obtains the emergent intensity of diffusely reflected radiation in a semi-infinite atmosphere of arbitrary stratificatio The result reduces to that given by Sobolev (Abstr. 5207 of 1957) and later by the author (Abstr. 14551 of 1960).

GENERAL MECHANICS

10455 SELECTED PAPERS ON STRESS ANALYSIS. London: Chapman and Hall; New York: Reinhold Publishing Corporation (1961) 114 pp.

These 18 papers were presented at the Institute of Physics Stress Analysis Group Conference held at Delft in April 1959. A summary is given of the remaining 33 papers. Abstracts of the papers printed in this volume will be found in this or succeeding issues of Physics Abstracts.

10456 SCHWARTZ'S ALGORITHM IN STRESS PROBLEMS O THE THEORY OF ELASTICITY. E.N.Nikol'skii.
Dokl. Akad. Nauk SSSR, Vol. 135, No. 3, 549-52 (Nov. 21, 1960). In Russian.

For abstract, see Abstr. 5240 of 1961. [English translation in: Soviet Physics—Doklady (USA), Vol. 5, No. 6, 1357-60 (May-June, 1961)].

10457 INVESTIGATION OF THE DYNAMIC STABILITY OF PLATES USING AN ELECTRONIC DIGITAL COMPUTER. A.Yu.Birkgan and A.S.Vol'mir.
Dokl. Akad. Nauk SSSR, Vol. 135, No. 5, 1083-5 (Dec. 11, 1960). In Russian.

For abstract, see Abstr. 4292 of 1961. [English translation Soviet Physics—Doklady (USA), Vol. 5, No. 6, 1364-8 (May-June, 1961)].

10458 STRESS DISTRIBUTION ON THE BOUNDARY OF AN ELLIPTICAL HOLE IN A LARGE PLATE DURING PASSAGE OF A STRESS PULSE OF LONG DURATION (MAJOR AXIS NORMAL TO THE WAVE FRONT). A.J.Durelli and W.F.R
J. appl. Phys. (USA), Vol. 32, No. 7, 1255-60 (July, 1961).

A solution to the problem is presented. The major axis of th ellipse is normal to the wave front. The solution was obtained experimentally by using a low modulus model material in a comb photoelasticity and moiré analysis. The long-duration stress pul was applied by loading a small region on an edge of the plate with falling weight. The results of the investigation indicate that the falling weight loading generates a biaxial state of stress at every point in the plate, which varies with time. The maximum dynami compressive stresses on the hole boundary can be computed with fair degree of accuracy by using: (a) the equation of Inglis for th static stress distribution on the boundary of an elliptical hole in two-dimensional uniform and axial system of combined stress an (b) the biaxial stresses, at the same instant of time, that would h been present at the centre of the ellipse if there had been no hole (free-field stresses). The maximum dynamic tensile stresses on the hole boundary were always smaller than the values computed using this same procedure.

10459 CALCULATION OF DEFLECTION IN COMBINED ELASTIC-PLASTIC BENDING. A.Troost.
Naturwissenschaften (Germany), Vol. 48, No. 2, 40-1 (1961). In German.

Difficulties arise in the analytical integration of the differen equations of systems in which there is elastic and plastic bending This note describes an approximate graphical solution based on t relationship between the curvature of a beam and the deflection o a limited length and an example is worked out.
H.J.H.Sta

10460 STEADY-STATE THERMOELASTICITY FOR INITIALLY STRESSED BODIES.
I.England and A.E.Green.
.l. Trans A (GB), Vol. 253, No. 1034, 517-42 (1961).
An elastic body, deformed from a state of zero stress and ain and uniform temperature by a large deformation and steady- te temperature distribution, is subsequently subjected to small placements and steady-state temperature distributions. After eneral analysis of the problem the work is specialized to the se when the initial large deformation is homogeneous at constant nperature. A general solution of the equations for the small perposed deformation and steady-state temperature distribution obtained in terms of three stress functions valid for some gions of space including the half space and thick uniform plate, en two perpendicular extension ratios of the initial homogeneous formation are equal. Applications are made to problems of a ne circular (penny-shaped) crack in an infinite medium and to lf-space problems.

10461 THE STABILITY OF FORCED OSCILLATIONS IN A SELF-ROTATING SYSTEM. M.Ya.Kushul'.
kl. Akad. Nauk SSSR, Vol. 136, No. 4, 787-90 (Feb. 1, 1961). Russian.
For abstract, see Abstr. 5244 of 1961. [English translation in: viet Physics—Doklady (USA), Vol. 6, No. 2, 128-30 (Aug., 1961)].

10462 DAMPED FREE OSCILLATIONS OF A GYROSCOPIC SYSTEM. R.Parks and L.Maunder.
ature (GB), Vol. 190, 710 (May 20, 1961).
The equations of angular oscillations under certain stated nditions show that in a gyroscopic motion the friction does not cessarily introduce reduction of the frequency of free vibrations. ven if this frequency is independent of viscous friction of the ner and the outer gimbal axes, the reduction is very small and ie motion can never be critically damped. J.K.Skwirzynski

MECHANICAL ANALOGUE OF THE ZEEMAN EFFECT.
e Abstr. 10302

MECHANICAL MEASUREMENTS

10463 ASSESSMENT OF THE ACCURACY OF "FLYING-SPOT" SCANNING FOR THE MEASUREMENT OF MICRO-SCOPIC PARTICLES. C.G.L.Furmidge.
rit. J. appl. Phys., Vol. 12, No. 6, 268-74 (June, 1961).
A critical review of the reliability and accuracy of the method. he instrument used was the "Flying-spot particle resolver" manu- ctures by Messrs. Rank Cintel Ltd. Most of the results quoted ere obtained using a reflected-light scanning technique for the easurement of spray droplet stains, but it is probable that the nclusions may be applied to the measurement of many other types microscopic particles. The possible errors associated with utomatic methods of measurement have been considered under the eadings: (a) errors inherent in the design of the instrument;) errors due to faulty operation of the instrument; (c) errors due the nature of the sample being measured. The accuracy and eliability of the automatic assessment of particle size has been ompared with the visual assessment, using a standard optical icroscope. It is concluded that the speed and reliability of auto- atic measurement are considerably greater than can be achieved y visual measurement. Basically the instrument is very accurate ut the accuracy with which a particular sample is assessed depends a considerable extent on the nature of the sample. Inaccuracies re introduced by overcrowding or aggregation of the particles on ne sample, by irregularly shaped particles and by the absence of ell-defined, clear-cut edges to the individual particles on the ample. The importance of these possible inaccuracies is discussed.

10464 Kr^{86} AND ATOMIC-BEAM-EMITTED Hg^{198} WAVELENGTHS. R.L.Barger and K.G.Kessler.
. Opt. Soc. Amer., Vol. 51, No. 8, 827-9 (Aug., 1961).
The present investigation was undertaken in order to calibrate he Hg^{198} resonance line in terms of the wavelength of the 6057 A ine of Kr^{86} as part of the investigation into the problem of rede- ining the standard of length in terms of a wavelength of light. Vacuum wavelengths are given for the Hg^{196} 2537 and 3132 A lines nd the Kr^{86} 6013 and 5651 A lines, referred to the Kr^{85} primary tandard line 6057 A. The light sources were an Hg^{198} atomic beam nd a Kr^{86} hot-cathode lamp. A vacuum Fabry–Perot interfero- neter was employed for the measurements. The wavelength of the Hg^{196} 3132 A line was also determined by using the Hg^{198} 2537 A line as the reference standard. The accuracy of measurement of the Hg^{196} lines is about a factor of 5 higher than that of the Kr^{86} lines.

10465 DIFFERENTIAL VOLUMENOMETER FOR MEASURING MINUTE VOLUME CHANGES IN SOLIDS.
R.Lowrie and F.Slish.
J. sci. Instrum. (GB), Vol. 38, No. 7, 278-81 (July, 1961).
The design and use of a differential volumenometer for measuring volume changes of solid sample to ±5 parts per million are described. The sample, sealed in a reservoir with only a capillary outlet, is covered with mercury, in which it must not be soluble. Any alteration in the sample volume, such as might be produced by heating it while in the volumenometer, is detected as a change in the level of the mercury meniscus in the capillary. Measurements of this level are made while the volumenometer is held at a standard temperature. The volumenometer may be heated to at least 250°C to produce changes in a sample. During the heating of volumenometers containing metal samples, small amounts of gas were observed to evolve under the mercury. This affects the measurements, and a procedure is described for removing such gas from the volumenometer. Data on the volume changes occurring during the annealing of cold-worked titanium in stages between 25° and 250°C are presented as an example of the application of this instrument.

10466 A SIMPLE VOLUMENOMETER.
R.G.Loasby.
J. sci. Instrum. (GB), Vol. 38, No. 7, 306 (July, 1961).
A volumenometer is described which utilizes the linear expansion of an oil-filled metal bellows to measure the volume expansion of solid materials.

10467 A METHOD FOR GAUGE FACTOR DETERMINATION.
I.G.Scott.
J. sci. Instrum. (GB), Vol. 38, No. 7, 291-3 (July, 1961).
A simple device for the determination of gauge factor of electrical resistance strain gauges is described.

10468 METHOD OF DENSITY DETERMINATION ON A MICRO-SCALE. J.M.Jones.
J. sci. Instrum. (GB), Vol. 38, No. 7, 303-4 (July, 1961).
The sample is suspended in a liquid of graded density contained within a hollow prism. This permits the determination of the refractive index of the liquid at the level of the suspended sample, from which the density of the liquid, and therefore of the particles, may be obtained.

10469 INHERENT LIMITATIONS OF ACCELEROMETERS FOR HIGH-FREQUENCY VIBRATION MEASUREMENTS.
F.Schloss.
J. Acoust. Soc. Amer., Vol. 33, No. 4, 539 (April, 1961).
When an accelerometer is attached to a vibrating mass the inertia of the transducer together with the elasticity of the mass produce a frequency-dependent error which sets an upper limit to the measurable frequency. A formula is given which enables this critical frequency to be calculated for a large plate. The transducer resonant frequency is assumed to be higher than the critical frequency. T.S.E.Thomas

10470 SIMPLE APPARATUS FOR COMPARATIVE DENSITY MEASUREMENTS. J.Pelsmaekers and S.Amelinckx.
Rev. sci. Instrum. (USA), Vol. 32, No. 7, 828-30 (July, 1961).
An apparatus was constructed for comparative density measurements in solids. The method is based on the measurement of the level of flotation of a series of specimens in a known density gradient, introduced in a column of liquid. The description of the apparatus, a discussion of the method, the measuring procedure, and the precision is given.

10471 THERMISTOR PRESSURE GAUGE DESIGN.
A.P.Flanick and J.E.Ainsworth.
Rev. sci. Instrum. (USA), Vol. 32, No. 3, 356-8 (March, 1961).
A discussion of the design characteristics of a specific gauge as an aim towards elimination of the need for trial and error methods in gauge construction. T.C.Toye

10472 SUGGESTED ARRANGEMENT OF MIRRORS TO FORM MULTIPLE REFERENCE ANGLES. J.B.Saunders.
J. Opt. Soc. Amer., Vol. 51, No. 8, 859-62 (Aug., 1961).
A reference angle is described that forms, by successive or

multiple reflections, a multiplicity of equal optical angles having common vertices. This angle may be used as a standard for calibrating circular scales either with an autocollimator or an interferometer. The angle can be adjusted in an interferometer to a very high accuracy. If the faces of the mirrors are 6 in. long, an error of 0.1 fringe corresponds to an error in the angle of 0.02 sec of arc.

10473 LOW IMPEDANCE BRIDGE FOR THE MEASUREMENT OF LEVEL OF LIQUID METALS. J.Hyman, Jr.
Rev. sci. Instrum. (USA), Vol. 32, No. 7, 833-7 (July, 1961).

A means is described whereby the liquid level of sodium or other conducting liquids may be determined within a sealed metal system. The measurement obtained is that of electrical resistance in an attached drain tube used as a metal "sight tube". A large alternating current is induced for the measurement by using the sealed metal system itself in conjunction with the "sight tube" as a one turn secondary of a transformer. Techniques necessary for application and temperature compensation are discussed.

10474 PROBLEMS IN THE ACCURATE MEASUREMENT OF TIME, AND INVESTIGATIONS OF PROCESSES OF ULTRA-SHORT DURATION. (A REVIEW). S.D.Fanchenko.
Pribory i Tekh. Eksper. (USSR), 1961, No. 1, 5-15 (Jan.-Feb.).
In Russian.

Brief survey of methods for measuring very short time intervals with high relative and absolute accuracy, and their ultimate limitations. 35 papers covering the period 1949-1960 are reviewed. Oscillographic, photoelectric and statistical methods are considered.
S.Chomet

VERSATILE FLECTRIC STOP CLOCK SYSTEM.
See Abstr. 10652

MECHANICS OF FLUIDS

(See also Magnetohydrodynamics)

STABILITY OF AN INCOMPRESSIBLE IDEAL FLUID.
See Abstr. 10442

10475 END EFFECTS IN A FALLING-SPHERE VISCOMETER. A.D.Maude.
Brit. J. appl. Phys., Vol. 12, No. 6, 293-5 (June, 1961).

The calculations of Stimson and Jeffery (1926) of the force on two spheres moving coaxially through a very viscous liquid are extended to the case when the spheres move at different rates. This result is used to calculate the effect of the bottom of the vessel in a falling sphere viscometer and that of the upper surface of the liquid. Approximate solutions are also found in a form suitable for practical use.

10476 INTRINSIC VISCOSITY OF STIFF CHAINS. R.Ullman and A.Muzyka.
J. chem. Phys. (USA), Vol. 34, No. 4, 1461-2 (April, 1961).

10477 THE DYNAMIC BULK VISCOSITY OF POLYSTYRENE AND POLYMETHYL METHACRYLATE. R.Kono.
J. Phys. Soc. Japan, Vol. 15, No. 4, 718-25 (April, 1960).

The transverse and longitudinal wave measurement on polystyrene and polymethyl methacrylate was carried out at frequencies of 0.5, 1, and 2.25 Mc/s, in the temperature range 20°—190° C. For the transverse wave measurements, a modified rotating plate method was used. An energy-dissipating process associated with volume deformation was found in these polymers. The activation energy associated with shear deformation is somewhat different from that associated with volume deformation, so that the molecular mechanism involved in the two types of deformation may be different.

10478 THE STRUCTURE OF THE HYDRODYNAMICS OF A VISCOUS FLUID. D.D.Ivlev.
Dokl. Akad. Nauk SSSR, Vol. 135, No. 2, 280-2 (Nov. 11, 1960).
In Russian.

For abstract, see Abstr. 6827 of 1961. [English translation in: Soviet Physics—Doklady (USA), Vol. 5, No. 6, 1169-71 (May-June, 1961)].

10479 A POINT EXPLOSION IN AN INCOMPRESSIBLE IDEAL LIQUID IN THE GENERAL THEORY OF RELATIVITY. V.A.Skripkin.
Dokl. Akad. Nauk SSSR, Vol. 135, No. 5, 1072-5 (Dec. 11, 1960).
In Russian.

For abstract, see Abstr. 4254 of 1961. [English translation in: Soviet Physics—Doklady (USA), Vol. 5, No. 6, 1183-6 (May-June, 1961)].

10480 NONSTEADY PLANAR MOTION OF AN IDEAL INCOMPRESSIBLE LIQUID. V.I.Yudovich.
Dokl. Akad. Nauk. SSSR., Vol. 136, No. 3, 564-7 (Jan. 21, 1961).
In Russian.

For abstract, see Abstr. 6828 of 1961. [English translation in: Soviet Physics—Doklady (USA), Vol. 6, No. 1, 18-20 (July, 1961)].

10481 CONVECTIVE CIRCULATION IN WATER INDUCED BY EVAPORATIVE COOLING.
W.G.Spangenberg and W.R.Rowland.
Phys. of Fluids (USA), Vol. 4, No. 6, 743-50 (June, 1961).

Schlieren photographs taken simultaneously from the top and side of a tank of water were used to study convection currents induced by evaporative cooling. It is found that water from the cooled surface layer collects along lines producing thickened regio which become unstable and plunge in vertical sheets. Surface water then continues to flow downward through the sheets, reducing the cooled surface layer to a thin film. In top schlieren views the plunging regions sometimes appear straight, sometimes curved, and branched or terminated with no fixed pattern. The number of lines per unit area is a function of the cooling rate rather than the depth of the container. Reticulated surface patterns were observed only at particular cooling rates and columnar plunging occurred only on rare occasions. No distinctly different combination of conditions to differentiate between the causes of these different modes was evident. Numerical integration of the nonlinear temperature distribution in the cooled layer showed a critical Rayleigh number of 1193 when convective circulation started, and a Rayleigh number of 102 for maintaining an established uniform circulation.

10482 WAKES IN LIQUID—LIQUID SYSTEMS. R.H.Magarvey and R.L.Bishop.
Phys. of Fluids (USA), Vol. 4, No. 7, 800-5 (July, 1961).

Evidence is presented to support a stable drop wake configuration consisting of a double row of vortex rings. This wake pattern is observed to be characteristic of liquid drops moving through a disperse liquid phase with Reynolds numbers appropriate to a range of non-oscillating drops. The wake configuration displays a high degree of symmetry and periodicity in the shedding of vortices. The wakes are rendered visible by the scrubbing of an aniline dye from the drop as it passes through the continuous phase. The larger oscillating drops leave wakes in which many rings are present, but the symmetry of the smaller drops is lacking.

10483 DUAL ROLE OF VISCOSITY IN THE INSTABILITY OF REVOLVING FLUIDS OF VARIABLE DENSITY. C.-S.Yih.
Phys. of Fluids (USA), Vol. 4, No. 7, 806-11 (July, 1961).

The stability of a viscous fluid between rotating cylinders and with a radial temperature gradient against the formation of axisymmetric disturbances (Taylor vortices) is considered, and it has been found that viscosity has a dual role. If the circulation increases radially outward (so that the flow would be stable in the absence of density variation) but the density decreases with the radial distance, the situation can arise that viscosity actually has a destabilizing effect. In the opposite circumstance, thermal diffusivity is always destabilizing. Detailed results for small spacing of the cylinders and sufficient conditions for stability of a revolving fluid of variable density or entropy also are given.

10484 STABILITY OF NONROTATIONALLY SYMMETRIC DISTURBANCES FOR VISCOUS FLOW BETWEEN ROTATING CYLINDERS. R.C.DiPrima.
Phys. of Fluids (USA), Vol. 4, No. 6, 751-5 (June, 1961).

The stability of a viscous fluid between two concentric rotating cylinders to nonrotationally symmetric disturbances is investigated. It is assumed that the cylinders are rotating in the same direction and that the spacing between the cylinders is small. It is found that the critical Reynolds number increases slightly as the "number of waves" in the azimuthal direction in the assumed form of the disturbance increases.

10485 FLOW AROUND A SPHERE IN A CIRCULAR TUBE. W.R.Smythe.
...s. of Fluids (USA), Vol. 4, No. 6, 756-9 (June, 1961).
The vector potential for the flow of an ideal fluid through a tube ...taining a concentric spherical obstacle is found for ratios of ...ere radius to tube radius of 0.1, 0.2, 0.3, 0.4, 0.5, 0.6, 0.7, 0.8, ..., and 0.95. The flow is confined to the space between sphere and ...inder by thin vortex sheets of variable strength and a table of ...ir circulation on the spherical surface is given. Accuracies vary ...m about one part in 10^8 for small spheres to one part in 10^7 for ...ge ones. The increase in the scalar velocity potential between ...ends of the tube caused by the insertion of the sphere is expressed ...terms of the effective increase in tube length. This also gives ...increase in resistance of a solid conducting cylinder due to the ...esence of a concentric spherical bubble.

THERMAL EXCHANGE FOR NON-NEWTONIAN FLUIDS IN ...MINAR MOTION IN CIRCULAR TUBES. II. THERMAL ...CHANGE FOR VARIABLE WALL. See Abstr. 10617

10486 A CONTRIBUTION TO THE THEORY OF ANISOTROPIC TURBULENCE. V.G.Nevzglyadov.
...kl. Akad. Nauk SSSR, Vol. 135, No. 2, 283-6 (Nov. 11, 1960). ...Russian.
For abstract, see Abstr. 4302 of 1961. [English translation in: ...viet Physics—Doklady (USA), Vol. 5, No. 6, 1172-5 (May-June, ...61)].

JETS OF A PERFECTLY CONDUCTING INVISCID GAS IN ...HE PRESENCE OF MAGNETIC FIELD PARALLEL TO THE ...TREAM. See Abstr. 10772

10487 A CONTRIBUTION TO THE THEORY OF CAUCHY–POISSON WAVES AT SLOPING BANKS. N.Rumyantsev.
...kl. Akad. Nauk SSSR, Vol. 135, No. 2, 287-9 (Nov. 11, 1960). ...Russian.
For abstract, see Abstr. 4314 of 1961. [English translation in: ...viet Physics—Doklady (USA), Vol. 5, No. 6, 1176-8 (May-June, ...61)].

10488 A CONTRIBUTION TO THE STATISTICAL DYNAMICS OF TURBULENT [FLOW OF] INCOMPRESSIBLE ...IQUIDS. B.I.Davydov.
...okl. Akad. Nauk SSSR, Vol. 136, No. 1, 47-50 (Jan. 1, 1961). ...n Russian.
For abstract, see Abstr. 4308 of 1961. [English translation in: ...oviet Physics—Doklady (USA), Vol. 6, No. 1, 10-12 (July, 1961)].

10489 DEPENDENCE OF THE CAVITATIONAL EROSION ON THE SOLUBILITY OF GAS ABOVE A CAVITATING ...IQUID. A.S.Bebchuk and L.D.Rozenberg.
...kust. Zh. (USSR), Vol. 6, No. 4, 498-9 (1960). In Russian.
The cavitational erosion in a liquid depends on a counter-...ressure in cavitation bubbles. This counter-pressure consists of ...e saturated vapour pressure of the liquid and the pressure of ...ases dissolved in the liquid which manage to diffuse into the ...ubbles. The present note deals with the second component of ...ounter-pressure in the case of water and ethyl alcohol in which ...xygen, nitrogen and carbon dioxide were dissolved. It was found ...hat with increase of the solubility of a gas in water or ethyl ...lcohol, the cavitational erosion fell monotonically, reaching zero ...t high solubility. The larger the amount of a gas in a liquid, the ...arger the pressure in the bubbles and the weaker the erosion of a ...olid due to collapse of such bubbles. [English translation in: ...oviet Physics—Acoustics (USA), Vol. 6, No. 4, 496-8 (April-June, ...1961)]. A.Tybulewicz

10490 A HYDRODYNAMICAL ANALOGUE FOR THE SKIN-EFFECT IN ELLIPTICAL CYLINDERS. ...J.Bauer and E.Pfleger.
...Acta phys. Austriaca, Vol. 14, No. 1, 29-38 (1961). In German.
The oscillations of fluid motions in pipes of elliptical cross section are studied. The amplitude of these oscillations is maximal near the walls at large Reynolds numbers (annular effect). The results generalize those of Sexl (Abstr. 2610 of 1930) for cylinders of circular cross section. T.Erber

10491 A CONTRIBUTION TO THE THEORY OF FREE FINITE OSCILLATIONS OF THE SURFACE SEPARATING TWO UNBOUNDED LIQUIDS OF DIFFERENT DENSITIES SUBJECT TO GRAVITY. Ya.I.Sekerzh-Zen'kovich.
Dokl. Akad. Nauk SSSR, Vol. 136, No. 1, 51-4 (Jan. 1, 1961). In Russian.
For abstract, see Abstr. 4315 of 1961. [English translation in: Soviet Physics—Doklady (USA), Vol. 6, No. 1, 13-15 (July, 1961)].

10492 OSCILLATIONS IN A VISCOUS LIQUID WITH AN APPLICATION TO TIDAL MOTION. J.N.Hunt.
Tellus (Sweden), Vol. 13, No. 1, 79- 4 (Feb., 1961).
Oscillatory laminar flow is considered in a liquid consisting of two superposed layers of different densities and viscosities, and the steady second order drift velocity outside the boundary layer is calculated for various density and viscosity ratios and heights of interface above the boundary. When the layer next to the boundary is the more viscous, and the density difference negligible, then the drift velocity exceeds Schlichting's value for a uniform liquid [Boundary Layer Theory. London: Pergamon (1955)]. The model is related to the motion of sediment layers in tidal estuaries, and a general landward drift of sediment is deduced.

10493 THE MOLECULAR HYDROSTATIC ANALYSIS OF GIBBS' THEORY OF CAPILLARITY. F.P.Buff.
Disc. Faraday Soc. (GB), No. 30, 52-7 (1960).
Examines the Gibbs postulate from the point of view of molecular hydrostatics. With use of the equation of hydrostatics and a stress tensor with unequal tangential components, the equilibrium conditions and work elements are computed. This general stress tensor implies that the work and the surface analogue of the equation of hydrostatics contain two tensions rather than the earlier single surface free energy. The normal component of the two-dimensional hydrostatic equation leads to a generalized Laplace equation and the tangential components determine the spatial dependence of the tensions. The Gibbs postulate is found correct only when to first-order terms the two tensions are taken to be equal. This equality is shown valid for representative surfaces.

10494 THE INFLUENCE OF A FOREIGN FILM ON EVAPORATION OF LIQUID DROPS.
B.V.Derjaguin, S.P.Bakanov and I.S.Kurghin.
Disc. Faraday Soc. (GB), No. 30, 96-9 (1960).
A formula for the quasi-stationary evaporation rate of a liquid drop covered with a film of a surface-active substance is obtained. It is proved that when the surface of the liquid is covered with such a film, the evaporation rate may not only fall, but also grow, due to an increase in the accommodation coefficient. The problem of non-stationary evaporation of a drop from a flat surface covered with a film is considered. Fairly simple formulae for the initial evaporation rate are deduced. It appears that this rate can be lower as well as higher than that of stationary evaporation, which is in agreement with known experimental results obtained for water covered with an absorbed layer of isoamyl alcohol.

10495 FLOW PATTERNS IN PARTICLE BEDS. N.J.Hassett.
Nature (GB), Vol. 189, 997-8 (March 25, 1961).
Further work on the use of glass sphere aggregates in the study of fluidized bed behaviour. Variation of velocity shows transition from one type of fluidization to another. During transition, low density, mushroom shaped discontinuities can be observed and the generic term "parvoid" is suggested to describe such low density discontinuities. T.C.Toye

LIQUID STATE

(Liquid helium is included under Low-Temperature Physics)

10496 DETERMINATION OF THE NON-LINEARITY PARAMETER FOR LIQUIDS FROM OPTICAL MEASUREMENTS. M.A.Breazeale and E.A.Hiedemann.
Naturwissenschaften (Germany), Vol. 47, No. 10, 222 (1960).
These can be determined using formulae relating the refractive index and density. A few values are calculated from the data of Gibson and Kincaid (Abstr. 1811 of 1938). H.D.Parbrook

10497 DEVELOPMENT OF THE LIQUID EQUATION AND THE PARTIAL STRUCTURE OF WATER. R.Ginell.
J. chem. Phys. (USA), Vol. 34, No. 6, 2174-6 (June, 1961).

In a previous publication where the derivation of the Tait equation for liquids is given, (Abstr. 6852 of 1961) the number average degree of association and the volume of holes depended on a sum

$$\phi = \sum_{x=1}^{\infty} s_x(1/v)^x.$$

This sum is transformed here into a closed expression. Hence these quantities can now be evaluated numerically along any isobar or isotherm in terms of one undetermined constant at a particular reference temperature. In terms of this development, the structure of water is analysed along an isobar (1 atm) from 20°-75°C and along an isotherm (20°C) from 1-200 atm.

10498 TRANSPORT COEFFICIENT RATIOS FOR ISOTOPICALLY SUBSTITUTED MOLECULES IN THE LIQUID PHASE AND THE TRANSPORT MECHANISM. E.McLaughlin.
Physica (Netherlands), Vol. 26, No. 8, 650-2 (Aug., 1960).

Dimensional analysis is applied to the transport coefficients of compounds of hydrogen and the corresponding compounds of deuterium. The ratio of viscosities is experimentally in agreement with the argument in the case of methane, benzene and cyclohexane. For water the ratio of thermal conductivities agrees well with the dimensional formula, but that of the viscosities does not. R.Eisenschitz

10499 A CORRECTION TO THE SMOLUCHOWSKI EQUATION IN THE MOLECULAR THEORY OF LIQUIDS. A.Suddaby and J.R.N.Miles.
Proc. Phys. Soc. (GB), Vol. 77, Pt 6, 1170-4 (June, 1961).

The Smoluchowski equation has been used to obtain the distribution function in coordinate space of pairs of molecules in a non-uniform liquid and hence to calculate the viscosity and flow anisotropy. This equation is the first approximation in an expansion of the Kramers—Chandrasekhar equation in inverse powers of the friction constant. In this paper, the second approximation, which leads to a fourth-order differential equation, is considered. The equation is solved numerically and the contributions to the radial distortion of the pair distribution and to the flow anisotropy are calculated for chloroform. It is found that the friction constant must be at least 4×10^{12} sec^{-1} for the Smoluchowski equation to be a reasonable approximation.

10500 A NEW APPROACH TO THE THEORY OF CLASSICAL FLUIDS. II. MULTICOMPONENT SYSTEMS. K.Hiroike.
Progr. theor. Phys. (Japan), Vol. 24, No. 2, 317-30 (Aug., 1960).

The results derived in Pt I (Abstr. 2749 of 1961) are generalized to the case of multicomponent systems. Similar arguments are used, though the derivation of the integral equation for the pair distribution function is given in a more intuitive way. The present theory is also a generalization of Morita's theory (Abstr. 14617 of 1960) in which multicomponent systems were treated in the hypernetted chain approximation.

10501 THEORY OF CLASSICAL FLUIDS AND THE CONVOLUTION APPROXIMATION (NOTE ON PAPERS BY TOHRU MORITA). E.Meeron.
Progr. theor. Phys. (Japan), Vol. 24, No. 3, 588-92 (Sept., 1960).

A method employed by Morita (Abstr. 14616-17 of 1960; 2748, 4323 of 1961) for the approximate calculation of the free energy and pair distribution function of classical fluids is seen to be identical with the nodal expansion method (Abstr. 5110 of 1957; 2177, 2820, 8600 of 1958). The limit of the nodal expansion sequence results in an approximate integral equation for the potential of average force. This convolution approximation is seen to be consistent with the Ornstein–Zernike theory of fluids, and thus provides a convenient means for investigating the behaviour of fluids near the critical point. The convolution approximation results also from neglecting the non-convolutory terms in an exact integral equation for the pair distribution function.

10502 ON THE THEORY OF CLASSICAL FLUIDS. L.Verlet.
Nuovo Cimento (Italy), Vol. 18, No. 1, 77-101 (Oct. 1, 1960).

A study of the development of the distribution function as a cluster series. The "chain" approximation is generalized by introducing all diagrams that can be obtained from the simple cha by progressively replacing single links by "bundles of chains". The final result is found to be equivalent to a nonlinear integral equation. Very similar work has been done independently by Meeron and also by Morita. See, for example, Prog. Theor. Phys 23, 829, (1960) and preceding abstract, which give references to earlier work]. H.N.V.Temperl

10503 FLUID SUPERPOSITION APPROXIMATION AND THE FOURTH VIRIAL COEFFICIENT. G.H.A.Cole.
J. chem. Phys. (USA), Vol. 34, No. 6, 2016-21 (June, 1961).

A new superposition approximation is given for relating the triplet distribution for a classical system of identical particles in interaction (fluid) to the pair distribution. The new approximation is based upon the well-known expression due to Kirkwood, but explicitly accounts for the particle density through a power series expansion. It is proposed that the coefficients of this expansion should be chosen in order to ensure internal consistency in the calculation of the virial coefficients of the pressure (when expressed in powers of the density) from either the pressure equation or the relative compressibility equation, and the necessary formulae are given. The equations are checked numerically for the ideal case o a gas of rigid spheres, as far as the fourth virial coefficient. The modified form of the original Kirkwood superposition approximatio which is the new approximation, is found for this case to be $g^{(3)}(r, s, t) = g^{(2)}(r)\,g^{(2)}(s)\,g^{(2)}(t)\,[1 + 0.1014bn]$ where $g^{(3)}$ is the tri let distribution, $g^{(2)}$ the pair distribution, n the particle number density, and b is equal to four times the volume of each particle. The theory then leads to a fourth viral coefficient of value $0.2885b^3$ which is to be compared with the exact value $0.2869b^3$. This value is found to be marked improvement on the values calculated by previous authors. The higher powers of n in the new superposition approximation necessary for the correct calculation of higher coefficients than the fourth are not considered.

10504 EQUATION OF STATE. K.Singh.
J. sci. industr. Res. (India), Vol. 20 A, No. 4, 197-209 (April, 1961).

Review of theoretical approaches that have been made to the equations of state of liquids and dense gases, with outlines of the derivations of the different formulae, and with some critical discussion. 46 references. J.Hawgoo

10505 ON THE EXCESS THERMODYNAMIC PROPERTIES OF ^{3}He—^{4}He AND H_2—D_2 LIQUID MIXTURES. M.Simon and A.Bellemans.
Physica (Netherlands), Vol. 26, No. 3, 191-7 (March, 1960).

The theory of isotopic mixtures developed by Prigogine et. al. is applied to these liquid mixtures. The excess thermodynamic properties are evaluated, starting from the pure isotopes, by a graphical method. The theoretical predictions are compared with the experimental values. The values obtained for the free energy excess and volume excess are very satisfactory but the entropy excess appears not to be in agreement with the experimental data for He^3—He^4 mixtures. F.E.Hoar

ON THE CHANGE IN THE THERMAL CONDUCTIVITY OF TI BISMUTH AND GALLIUM ON MELTING. See Abstr. 9990

10506 RECTIFIED DIFFUSION: COMMENTS ON A PAPER O HSIEH AND PLESSET. M.Strasberg.
J. Acoust. Soc. Amer., Vol. 33, No. 3, 359 (March, 1961).

See Abstr. 4313 of 1961. The author's measurements of the "thresholds for rectified diffusion" are reasonably in agreement with the formula by Hsieh and Plesset but do not agree satisfactor with formulae given by other writers. R.Eisensch

10507 COMMENTS ON THE THEORY OF RECTIFIED DIFFUSION. M.S.Plesset and D.Y.Hsieh.
J. Acoust. Soc. Amer., Vol. 33, No. 3, 359-60 (March, 1961).

(See preceding abstract). It would appear that it is essential to take account of convection in the theory of "rectified diffusion". R.Eisensch

10508 INFLUENCE OF THE MOLECULAR WEIGHT DISTRIBUTION ON THE POLYMER PROPERTIES. A.Miyake and H.Adachi.
J. Phys. Soc. Japan, Vol. 15, No. 5, 883-7 (May, 1960).

The Schulz—Zimm expression of the molecular weight distribution in a polymer sample is conveniently extended in terms of associated Laguerre polynomials. Applying the present expressio the influence of the molecular weight distribution is investigated,

ecially on the osmotic pressure and on the intra- and intermolecr light scattering. The second virial coefficients in the osmotic ssure expression and in the intermolecular light scattering ction for the polydisperse polymer are examined.

10509 DIFFUSION OF SMALL MOLECULES.
C.Rossi and E.Bianchi.
ture (GB), Vol. 189, 822-4 (March 11, 1961).

In continuation of former work, measurements were made of the fusion of various simple substances in heptane. It is found that olecules larger than the solvent molecules obey the Einstein-Stokes uation accurately but molecules smaller than the solvent molecules ffuse more slowly the smaller they are. Similar behaviour is nd when benzene is the solvent. It is concluded that the diffusion ethod of determining the dimensions of polymer molecules in lution is satisfactory. It is shown that the data for the smaller olecules can be represented satisfactorily by an empirical equation simple form. H.N.V.Temperley

10510 DIFFUSION OF NEON, HT, AND DEUTERIUM IN LIQUID HYDROGEN.
.Cini-Castagnoli, A.Giardini-Guidoni and F.P.Ricci.
hys. Rev. (USA), Vol. 123, No. 2, 404-6 (July 15, 1961).

Experimental results on diffusion of Ne, HT, and D_2 in liquid $_2$ are reported and analysed using the corresponding states prinple. The features of the quantum deviations are indicated.

10511 ON THE THEORY OF ION PAIRS IN SOLUTIONS.
J.C.Poirier and J.H.DeLap.
. chem. Phys. (USA), Vol. 35, No. 1, 213-27 (July, 1961).

Following the general lines of Fuoss' early analysis, two alterate definitions of ion partners (1) excluding and (2) including artners composed of ions having the same electrical sign are ormulated. The resulting sets of coupled integral equations for he ion-partner radial distribution functions $G_{ij}(r)$, differ from Fuoss' by the inclusion of a factor for the probability that the rbital ion does not have a partner closer than the central ion and re valid for electrolytes of any symmetry type or any mixture of lectrolytes at any concentration for which the ordinary pair orrelation functions $g_{ij}(r)$ for the various types of pairs of ions re known. By the presented iterative numerical method, the set f equations resulting from either definition (1) or (2) may be olved even for a general mixture. Explicit analytical solutions for $G_{ij}(r)$ in terms of an arbitrary (except for an easily relaxed restriction of a hard core) $g_{ij}(r)$ are presented for the following lectrolytes: definition (1) symmetrical and unsymmetrical binary; definition (2) symmetrical binary with equal ionic radii. For examples of these electrolytes, graphs of $G_{ij}(r)$ resulting from the se of the Debye–Hückel model and the infinite dilution form of $g_{ij}(r)$ are presented (cations, 10^{-4} M; D = 20; T = 25°C; interionic distance of closest approach, 4.6 A). Numerically obtained $G_{ij}(r)$ are also presented for a 1-1 electrolyte with unequal ionic radii [definition (2); conditions as above except ionic radii of 1.6 A and 3.0 A] and a mixture of two 1-1 electrolytes with a common anion [definition (1); interionic distance of closest approach of the second electrolyte, 7.0 A]. More extensive ion pair formation of the smaller cation shown in the latter case qualitatively explains anomalously low conductance in mixtures. The $G_{ij}(r)$, markedly smaller than the corresponding Fuoss curve at large separation, lead to the same association constant K^{-1} if the same critical distance is used to terminate the ion pair range; a constant critical distance, however, leads to a K^{-1} which is a continuous function of DT in qualitative agreement with some conductance data and is compatible with a "contact ion pair" concept. An equation for the activity coefficient ratio is presented and degrees of association are calculated in a variety of solutions. The formalism presented easily accepts more realistic $g_{ij}(r)$ functions and can be extended to entirely different types of systems. The usefulness of the ion (or particle) pair approach is briefly discussed.

10512 ULTRASONIC SPECTROSCOPY IN SOLUTIONS OF HIGH POLYMERS. INFLUENCE OF THE NATURE OF THE POLYMER AND OF ITS MOLECULAR WEIGHT.
S.Candau, R.Zana and R.Cerf.
C.R. Acad. Sci. (France), Vol. 252, No. 15, 2229-31 (April 10, 1961).
In French.

A comparative study using a previous described method (Abstr. 6938 of 1961) is reported of the specific ultrasonic absorption as a function of frequency (0.8-20 Mc/s) of polystyrene, methyl polymethacrylate, methyl polyacrylate, and n-octacosane, monodispersed in benzene. It is found that the number and slope of the absorption curves depend on the lateral groups and on the degree of polymerization. H.H.Hodgson

10513 THEORY OF VIBRATIONAL RELAXATION IN LIQUIDS. R.Zwanzig.
J. chem. Phys. (USA), Vol. 34, No. 6, 1931-5 (June, 1961).

A new formulation of the theory of vibrational relaxation, based on Zener's semiclassical approximation, is presented. The relaxation rate is shown to be proportional to the spectral density of the force exerted on the oscillator by its environment. The isolated binary collision theory is derived, but only with the condition that the collision frequency is much smaller than the oscillator frequency. This requirement is not satisfied in a liquid; it is concluded that Litovitz's application of the isolated binary collision theory to liquids is not justified. A possible relation between vibrational relaxation and the self-diffusion coefficient in a liquid is discussed.

10514 INTERPRETATION OF THE ELECTRONIC AND VIBRATION ABSORPTION SPECTRA OF URANYL NITRATES. L.V.Volod'ko, A.N.Sevchenko and D.S.Umreiko.
Dokl. Akad. Nauk SSSR, Vol. 135, No. 3, 560-3 (Nov. 21, 1960). In Russian.

For abstract, see Abstr. 4344 of 1961. [English translation in: Soviet Physics—Doklady (USA), Vol. 5, No. 6, 1240-2 (May-June, 1961)].

10515 SOME EFFECTS OF TEMPERATURE AND VISCOSITY ON FLUORESCENCE AND ENERGY TRANSFER IN SOLUTIONS. A.Weinreb.
J. chem. Phys. (USA), Vol. 35, No. 1, 91-102 (July, 1961).

The transfer of excitation energy between molecules of different compounds in solutions is investigated as a function of temperature and viscosity of the solution. In all cases an increase in transfer efficiency with increasing diffusion is observed. The fluorescence of the donor molecules in the absence of acceptor molecules is studied as a function of temperature and the possible influence of the respective changes on the observed transfer efficiencies is discussed.

10516 EFFECT OF OXYGEN ON LIQUID SCINTILLATORS.
G.Laustriat and A.Coche.
C. R. Acad. Sci. (France), Vol. 252, No. 14, 2102-4 (April 5, 1961).
In French.

Studies were made of the quenching effect of oxygen on liquid scintillators, and its dependence on the nature of the solvent and solute and on the concentration. It is concluded that the effect is primarily due to the influence of oxygen on the solvent, and that the solvent–solute energy transfer is non-radiative. J.B.Birks

10517 EFFECT OF OXYGEN ON LIQUID SCINTILLATORS. INFLUENCE OF TEMPERATURE.
G.Laustriat and A.Coche.
C. R. Acad. Sci. (France), Vol. 252, No. 15, 2217-19 (April 10, 1961).
In French.

The effect of oxygen on the efficiency of liquid scintillators depends on temperature, but is not influenced by the presence of anti-oxidants. A study of the quenching effect on energy transfer from primary to secondary solute indicates that different modes of transfer are possible, depending on the secondary solute concentration. J.B.Birks

LUMINESCENCE OF CHRYSENE SOLUTIONS AT 77°K.
See Abstr. 10114

10518 A PHENOMENON IN n-HEXANE PRIOR TO ITS ELECTRIC BREAKDOWN. S.S.Hakim and J.B.Higham.
Nature (GB), Vol. 189, 996 (March 25, 1961).

Changes in the refractive index of the liquid near the cathode were recorded using schlieren techniques when a step function voltage was applied to two electrodes immersed in the liquid. The polarity of the changes was not determined. W.G.Townsend

10519 A SIMPLE THEORY OF THE DIELECTRIC PROPERTIES OF HOMOGENEOUSLY ORIENTED LIQUID CRYSTALS OF THE NEMATIC TYPE. W.Maier and G.Meier.
Z. Naturforsch. (Germany), Vol. 16a, No. 3, 262-7 (March, 1961).
In German.

In this type of liquid the elongated molecules can be made to line up to a high degree by applying a magnetic field. The permittivity will then, in general, be anisotropic. Using Onsager's treatment of the static permittivity of dipolar liquids, the authors derive expressions for the permittivities measured parallel to and perpendicular to the orienting field. The anisotropies of both

induced and dipole orientation polarization are taken into account, but not that of the internal field. Comparison with experiment is reserved for a future paper. K.W.Plessner

10520 THE CONDUCTIVITY OF UNDEHYDRATED INSULATING LIQUIDS. R.Guizonnier.
J. Electrochem. Soc. (USA), Vol. 108, No. 6, 519-22 (June, 1961).

The study allows the redetermination of the variations in conductivity of water in relation to its temperature to be made:

$$i_0 = Ae^{-W/kT}$$

where W = 0.41 eV, and shows (a) the point of solidification of water, (b) the change in the properties of water, between 30° and 40°, and (c) a residual difference of potential, as well as the water, between 0.9-1.7 V.

10521 EFFECT OF O_2 ON LINE WIDTH AND RELAXATION IN E.S.R. K.H.Hausser.
Arch. Sci. (Switzerland), Vol. 13, No. Fasc. Spec., 239-42 (1960).

9th Colloque Ampere Paper (see Abstr. 4734 of 1961). The resolution of hyperfine structure in electron paramagnetic resonance in solutions depends upon the concentration of molecular oxygen in the solution. The influence of oxygen on the linewidth is illustrated by the example $(SO_2)_3NO^{2-}$. The spectrum of the radical 2, 4, 6-triphenyl-phenoxyl, unresolved under normal conditions, showed more than 100 hyperfine components after oxygen had been removed. In Wurster's Blue it is possible to resolve all of the 325 hyperfine components theoretically expected. J.M.Baker

10522 A TEST OF THE THEORIES OF MAGNETIC RESONANCE AND THE STUDY OF LIQUIDS BY THIS METHOD. J.G.Powles.
Arch. Sci. (Switzerland), Vol. 13, No. Fasc. Spec., 467-73 (1960).

9th Colloque Ampère Paper (see Abstr. 4734 of 1961). A review of the dependence of nuclear spin–spin and spin–lattice relaxation times in liquids on the correlation time or times of the molecular thermal motions, illustrated by reference to several types of liquids: and of the kinds of detailed information obtainable about the thermal motions. E.F.W.Seymour

10523 THE CONCENTRATION DEPENDENCE OF THE MAGNETIC SCREENING OF THE F^{19} NUCLEUS IN THE SYSTEMS KHF_2–H_2O AND KHF_2–KF–H_2O.
Van I-tsyu [Wang I-ch'iu] and F.I.Skripov.
Dokl. Akad. Nauk SSSR, Vol. 136, No. 1, 58-60 (Jan. 1, 1961).
In Russian.

For abstract, see Abstr. 6874 of 1961. [English translation in: Soviet Physics–Doklady (USA), Vol. 6, No. 1, 27-8 (July, 1961)].

10524 EFFECTS OF DIFFUSION IN NUCLEAR MAGNETIC RESONANCE SPIN-ECHO EXPERIMENTS.
D.E.Woessner.
J. chem. Phys. (USA), Vol. 34, No. 6, 2057-61 (June, 1961).

The spin-echo attenuation by molecular self-diffusion in an inhomogeneous magnetic field is calculated for three- or four-pulse sequences. The method employed avoids the question of an averaging procedure as discussed by Das and Saha. Experimental measurements yield confirmation of the three-pulse results.

MECHANICS OF GASES

10525 NOTE ON THE VISCOSITY OF N_2–CO_2 MIXTURES.
S.Weissman and E.A.Mason.
Physica (Netherlands), Vol. 26, No. 7, 531-2 (July, 1960).

It has recently been found that mixtures of N_2–CO_2 exhibit deviations from a linear mixing rule (at 20° C and pressures from 1 to 21 atmospheres), and that the equation of Wilke, which usually agrees well with experimental data, here predicts deviations of the opposite sign. It is suggested that this apparent anomoly corresponds to the behaviour of the thermal conductivity at high temperatures, and arguments are advanced in support of this suggestion. N.Curle

10526 VISCOSITY AND THERMAL CONDUCTIVITY OF BINARY GAS MIXTURES: KRYPTON–ARGON, KRYPTON–NEON, AND KRYPTON–HELIUM. E.Thornton.
Proc. Phys. Soc. (GB), Vol. 77, Pt 6, 1166-9 (June, 1961).

The coefficients of viscosity and thermal conductivity of binary mixtures of krypton with argon, neon and helium were determined over the full range of composition of each mixture at a pressure of 70 cm of mercury and at a temperature in the range 18.0° to 18.3°. The experimental values are compared with theoretical values based on the Lennard-Jones (6–12) potential of interaction betwe molecules. Agreement between the experimental and calculated values is generally satisfactory, but there are discrepancies between some of the measurements given here and those of other workers.

10527 VISCOSITY OF TWO-COMPONENT GASEOUS MIXTURES.
J.O.Hirschfelder, M.H.Taylor, T.Kihara and R.Rutherford.
Phys. of Fluids (USA), Vol. 4, No. 6, 663-8 (June, 1961).

The conditions are found where the viscosity of a binary mixture of dilute gases either has a maximum or minimum with respect to variations in the composition. A maximum in the visc is most likely to occur for a mixture of a polar and nonpolar gas which the viscosities of the pure components are nearly equal and their molecular weights are quite different. A minimum should occur for a mixture of two nonpolar gases in which both the viscosities and molecular weights of the pure components are nearly equal. There are 17 experimental examples of maxima (ar three additional mixtures with predicted maxima) in the viscosity but up to the present time no cases have been discovered where t viscosity has a minimum. A comparison between theory and expe ment shows excellent agreement for the viscosity of binary mixtu

10528 A CLASS OF SELF-SIMILAR [PATTERNS OF] MOTIO OF AN ULTRARELATIVISTIC GAS. V.A.Skripkin.
Dokl. Akad. Nauk. SSSR, Vol. 136, No. 4, 791-4 (Feb. 1, 1961).

For abstract, see Abstr. 6875 of 1961. [English translation i Soviet Physics–Doklady (USA), Vol. 6, No. 2, 115-17 (Aug., 1961)

STABILITY OF A CHARGED-PARTICLE GAS.
See Abstr. 10442

10529 A NON-LINEAR BOUNDARY VALUE PROBLEM IN HYPERSONIC GAS DYNAMICS. D.Naylor.
J. Math. Mech. (USA), Vol. 9, 665-80 (1960).

Plane flow is considered past a finite wedge followed by a parallel section of indefinite extent. The hypersonic small-disturbance approximation is adopted, and the adiabatic exponent γ taken as unity, which renders the flow effectively isentropic. (This is justified by appeal to the fact that flow past a cone is insensitive to the value of γ, but one could object that the sensitiv is much greater for the wedge). Characteristic variables are introduced, and Riemann's method leads to a Volterra integral equation for the shape of the shock wave. An approximate solutio is given, showing the ultimate decay to a Mach wave.
Mathematical Reviews (M.D.Van Dyk

10530 FLOW OF GAS THROUGH POROUS MEDIA IN THE REGION BETWEEN MOLECULAR AND VISCOUS CONDITION. E.H.Hirsch.
J. appl. Phys. (USA), Vol. 32, No. 6, 977-82 (June, 1961).

Experiments on the flow of gases through porous Pyrex disks at pressures in the range of a few mm Hg are described. For air hydrogen, and carbon dioxide the specific flow is found to be give by

$$Q = \frac{A}{(MT)^{1/2}} + \frac{B}{\eta T}\bar{p} + \frac{C}{M^{1/2}}\{1 - \exp[\alpha_0 - \beta T^{1/2}]\bar{p}\}$$

where $\bar{p}$ is the mean pressure. The significance of this result is discussed.

10531 A RIGOROUS SOLUTION OF THE EQUATIONS [GOVERNING] THREE-DIMENSIONAL NON-STATIONARY FLOW OF GASES OF THE DOUBLE-WAVE TYPE.
L.V.Komarovskii.
Dokl. Akad Nauk SSSR, Vol. 135, No. 1, 33-5 (Nov. 1, 1960).
In Russian.

For abstract, see Abstr. 4365 of 1961. [English translation i Soviet Physics–Doklady (USA), Vol. 5, No. 6, 1163-5 (May-June, 1961)].

10532 THE MOTION OF A RHOMBIFORM PROFILE WITH VELOCITY NOT EXCEEDING THE VELOCITY OF SOUND. S.K.Aslanov.
Priklad. Mat. i Mekh. (USSR), Vol. 22, No. 4, 452-64 (1958).
In Russian.

The flow of a gas round a rhombiform profile is analysed mathematically at subsonic and sonic velocities. R.F.S.Hearm

Shock Waves

10533 ESTIMATION OF THE CRITICAL VISCOUS SUB-LAYER IN SHOCK WAVE BOUNDARY LAYER INTERACTION.
K.Roy.
Angew. Math. Phys. (Switzerland), Vol. 10, No. 1, 82-9 (1959).

In a theory of the interaction between weak shock waves and undary layers, Lighthill has pointed out that disturbances to the cous forces (caused by the shock) are confined essentially to an er sub-layer. The author has estimated the thickness of this er, and finds that it is of order 10% of the total boundary layer ckness for a laminar layer and 1% for a turbulent layer. For bulent layers, it is accordingly well within the laminar sublayer.
N.Curle

10534 MEAN-FREE-PATH DEFINITION IN THE MOTT-SMITH SHOCK WAVE SOLUTION. S.Ziering and F.Ek.
ys. of Fluids (USA), Vol. 4, No. 6, 765-6 (June, 1961).

The bimodal analysis of Mott-Smith (Abstr. 6801 of 1951) lds a reciprocal shock thickness, reduced by a mean free path ead of the shock, that tends to zero for various intermolecular ws of force with increasing shock strength, yet remains finite r rigid-sphere molecules. It is shown that the introduction of a ntre of shock mean free path, self-consistent within the bimodal lution, results in finite reciprocal thicknesses for such diverse ws of interaction as inverse fifth and rigid-sphere molecules. hen reduced by a centre of shock mean free path, the reciprocal ickness is not too sensitive to the particular law of molecular teraction.

SHOCK WAVES PRODUCED BY EXPLODING WIRES.
e Abstr. 10693

MAGNETO-FLUID DYNAMIC SHOCK WAVES.
e Abstr. 10779

10535 PRESSURE SHOCKS IN VISCOUS HEAT-CONDUCTING GASES. T.Y.Thomas and C.R.Edstrom.
roc. Nat. Acad. Sci. (USA), Vol. 47, No. 3, 319-25 (March, 1961).

Various deductions are made about the propagation of shocks, ithout explicit use of the equations of heat-conduction and viscous ow. The conclusions are mainly about the geometrical form of the ave-surface.
H.N.V.Temperley

10536 SHOCK-WAVE CURVATURE AT LOW INITIAL PRESSURE. R.E.Duff and J.L.Young, III.
hys. of Fluids (USA), Vol. 4, No. 7, 812-15 (July, 1961).

The shape of the primary shock wave in a shock tube was easured by recording the time of arrival of the shock in argon at n array of piezoelectric detectors located along a diameter of a 8.6 mm i.d. shock tube operated at an initial expansion chamber ressure of 0.34 mm Hg. The following conclusions were drawn rom the results: (1) shock-wave tilt was negligibly small under the onditions of these experiments; (2) shock-wave curvature is ndependent of shock strength for shock Mach numbers from 1.8 to 3.3; (3) the shock-front shape is nearly spherical; (4) the axial extent or he bulge of the curved shock is approximately 1 mm. The axial extent of a shock in argon was also measured over the range of initial pressure from 0.1 to 20 mm Hg. It varies approximately as the inverse square root of the initial pressure.

10537 PROPAGATION OF DISCONTINUITIES IN SOUND WAVES. K.E.Gubkin.
Priklad. Mat. i Mekh. (USSR), Vol. 22, No. 4, 561-4 (1958).
In Russian.

A solution is given of the gas-dynamic equations describing the propagation of small-amplitude shock waves. For spherical and cylindrical propagation, the results agree with those of earlier workers.
R.F.S.Hearmon

10538 MACH REFLECTION OF DETONATION WAVES IN CONDENSED HIGH EXPLOSIVES. B.B.Dunne.
Phys. of Fluids (USA), Vol. 4, No. 7, 918-24 (July, 1961).

By pre-shocking a condensed high explosive before the passage of a detonation front, it is possible to increase the peak pressure in the front to a level at which reflection phenomena can be readily observed by means of the Dautriche effect. Also by the use of a tracer detonation wave, which intersects the shock configuration, it is possible to observe the oncoming detonation shock, the reflected shock, the Mach stem, and their intersection in a triple point. This method was used to obtain strong evidence for the existence of Mach reflection of detonation waves in a pre-shocked explosive (RDX). The transition from regular to Mach reflection for an estimated 50 kbar pre-compression shock occurs discontinuously at a critical angle of $44.5^\circ \pm 2^\circ$ and quite rapidly, often in less than 3×10^{-6} sec.

PROPAGATION OF SHOCK WAVES IN INHOMOGENEOUS GASES. See Abstr. 10774

10539 ON THE TRUE NATURE OF LUMINOUS PHENOMENA OBSERVED IN MAGNETICALLY DRIVEN SHOCK TUBES. M.Cloupeau.
C.R. Acad. Sci. (France), Vol. 251, No. 7, 918-20 (Aug. 17, 1960).
In French.

Experiments were performed on the reflection of a shock wave from a solid surface and also from another shock wave. Variations from expected behaviour were observed depending on the gas pressure and applied potential. It is suggested that the luminosity observed is not due to thermal effects of the shock wave but is caused by plasma ejected from the initial discharge which carries a shock wave with it.
J.W.Sturgess

10540 THEORY OF ELECTRON DRIVEN SHOCK WAVES. R.G.Fowler and B.D.Fried.
Phys. of Fluids (USA), Vol. 4, No. 6, 767-70 (June, 1961).

Previous calculations (Abstr. 2785 of 1961) of the time required for ion heating in the discharge or driver section of an electrical shock tube yielded values much greater than that in which formation and acceleration of the first luminous front is observed to occur. The model of an electron driven shock presented here shows that the relation between shock velocity V and electron temperature T_e, which has been established experimentally over a wide range of parameters, remains valid even though the conventional picture of a shock driven by hot ions must be abandoned. Thermal expansion of the hot electron gas accelerates the cold ions, resulting in a shock front or moving electrostatic double layer. Assuming conditions behind the shock to be coupled to those in the discharge region through a simple rarefaction wave, it is found that MV^2/kT_e is a universal function of W/MV^2, where W is the effective ionization potential. This is shown to be in excellent agreement with a wide variety of experimental data.

GASEOUS STATE

10541 DIFFUSIONAL TRANSPORT OF ATOMIC HYDROGEN THROUGH MOLECULAR HYDROGEN AT ELEVATED TEMPERATURES. H.Wise.
J. chem. Phys. (USA), Vol. 34, No. 6, 2139-41 (June, 1961).

Changes in the transport properties of a gas mixture of atomic and molecular hydrogen were measured in a temperature range from 300° to 700°K. The steady-state distribution of atoms diffusing from a source towards a catalytically active surface was determined in a cylinder of finite length. The experimental parameter of interest is the diffusion Reynolds number which contains the ratio of interdiffusion coefficient to recombination coefficient. If the catalytic activity of the surface is known, one may relate the atom-concentration gradient to the diffusion coefficient. In the temperature region studied the change in the binary diffusion coefficient for the system H, H_2 was evaluated. Based on the results obtained, the intermolecular force fields applicable to the atom–molecule encounters were examined.

10542 PURITY OF HELIUM PERMEATING THROUGH QUARTZ INTO A VACUUM SYSTEM. J.R.Young and N.R.Whetten.
Rev. sci. Instrum. (USA), Vol. 32, No. 4, 453-4 (April, 1961).

It is shown that the selective permeation of helium through quartz results in a reduction of impurities in the helium, after permeation, to less than 1 p.p.m. with the exception of hydrogen. The permeation rate for this gas accounts exactly for the measured hydrogen impurity found.
T.C.Toye

CAUCHY'S PROBLEM FOR THE EQUATION WITH MANY SPATIAL VARIABLES, FOR NON-STATIONARY FILTRATION OF A GAS. See Abstr. 10452

10543 SECOND VIRIAL COEFFICIENT OF BORON TRIFLUORIDE. C.J.G.Raw.
J. chem. Phys. (USA), Vol. 34, No. 4, 1452-3 (April, 1961).

The results of experimental determination of this are given for five temperatures in the range 20°-70°C. The Lennard-Jones potential gives adequate representation of the molecular interactions in gaseous boron trifluoride.
W.Good

10544 LINKED-DIAGRAM EXPANSION FOR THE EQUATION OF STATE OF A GAS OF MOLECULES.
A.N.Kaufman and K.M.Watson.
Phys. of Fluids (USA), Vol. 4, No. 6, 655-62 (June, 1961).

The method of the linked-diagram expansion is applied to the equilibrium statistical mechanics of a nondegenerate gas of molecules, taking into account the structure of the molecules, and using the Pauli principle for all the electrons. The equation of state is obtained in the form of a virial expansion analogous to that of Ursell and Mayer.

EQUATION OF STATE. See Abstr. 10504

10545 THEORY OF THE MOLECULAR FRICTION CONSTANT. E.Helfand.
Phys. of Fluids (USA), Vol. 4, No. 6, 681-91 (June, 1961).

The molecular friction tensor, as given by a time integral of an autocorrelation of forces, is calculated with the assumption that the trajectories of the particles are linear and unaccelerated for the times of interest. Such trajectories are appropriate to lowest order in the force on a particle. Application is made to particles interacting via a Coulombic potential. The result previously derived by Chandrasekhar is obtained without the introduction of a cutoff for large distances. To handle molecular systems the author treats the "soft" part of the potential by the linear trajectory technique, and adds a small term to account for hard-core collisions.

10546 KINETIC THEORY OF MODERATELY DENSE, RIGID-SPHERE GASES. P.M.Livingston and C.F.Curtiss.
Phys. of Fluids (USA), Vol. 4, No. 7, 816-33 (July, 1961).

By successive partial integrations of the Liouville equation, the hierarchy of BBGKY equations are obtained. The series is terminated at the second equation by the introduction of a superposition approximation. A specialization to rigid spheres is made early in the treatment. Then, after defining a non-equilibrium pair correlation function, the first BBGKY equation is identified as an Enskog equation modified by the inclusion of a momentum-dependent correlation function in the collision integral. This equation and the second BBGKY equation completely determine the singlet distribution and pair correlation functions. An approximate solution to this pair of equations follows from the usual linearized perturbation expansion of the singlet distribution and pair correlation functions for the system near equilibrium. A set of five equations in the coefficients of the gradients are obtained, and the coupling between them is resolved by expanding these coefficients in powers of the number density. Because of the limitations imposed by the superposition approximation, only the first few terms in the density expansions are considered explicitly. The solutions to these equations and the resulting modifications of the transport coefficients are discussed.

10547 DETECTION OF MOLECULAR COMPLEXES IN GASES BY ULTRASONIC METHOD. D.D.Deshpande.
Current Sci. (India), Vol. 29, No. 6, 224-5 (June, 1960).

Results on the ultrasonic absorption of mixtures of CO_2 and oxygen and of CO_2 and air are interpreted in terms of the formation of loose complexes in the gaseous state. G.I.W.Llewelyn

10548 LIGHT-WEIGHT REFRACTOMETER. D.R.Hay, H.C.Martin and H.E.Turner.
Rev. sci. Instrum. (USA), Vol. 32, No. 6, 693-7 (June, 1961).

Describes a 7 lb device that indicates changes in the refractive index of a gas. Because it is capable of detecting refractivity fluctuations that are as small as 1 in 10^6, it is useful in studying the irregularities in the refractive index of the troposphere that are important in short radio-wave transmission. The refractometer is self-contained, so that it may be used in controlled or in free ascent through the atmosphere. The device is essentially a high frequency oscillator whose frequency is governed by the capacitance of an air sensing condenser. Special provision is made for reliable operation over the wide range of temperatures normally found in the troposphere.

10549 THERMAL CONDUCTIVITY AND EQUILIBRIUM CONSTANT OF THE SYSTEM $N_2O_4 \rightleftharpoons 2NO_2$.
B.N.Srivastava and A.K.Barua.
J. chem. Phys. (USA), Vol. 35, No. 1, 329-34 (July, 1961).

An all-glass apparatus was used to measure the thermal conductivity of the system $N_2O_4 \rightleftharpoons 2NO_2$ by the thick-wire variant of the hot-wire method in a temperature range of 32°-90°C and up to a pressure of about 50 cm Hg. The apparatus is capable of measuring the equilibrium constant and the thermal conductivity of the system simultaneously. The experimental data are discussed in the light of theories based on the assumption of local chemical equilibrium. The discrepancy between the experimental and the calculated values of the heat conductivity which is particularly large at the lower pressures shows the necessity of applying nonequilibrium heat transfer theory to interpret the data.

10550 DETERMINATION OF THERMAL CONDUCTIVITY COEFFICIENTS OF GASES WITH A UNIVERSAL PLANE BICALORIMETER. G.M.Levin.
Pribory i Tekh. Eksper. (USSR), 1958, No. 1, 102-5 (Jan.-Feb.). In Russian.

The parallel-plate apparatus described in some detail was constructed in Sverdlovsk in 1956-57. It consists of a central Ni disk of 90 mm diameter and 8.5 mm height, surrounded by a guard ring of polystyrene foam and separated, by accurately measured rings, from Ni cover-plates. The apparatus is fitted within a brass case of 126 mm outside diameter and 35 mm height, The thermal conductivity was determined from the rate of cooling of the central disc. Direct measurements may be made when both working chambers are filled with the material under study (the symmetrical case), or relative measurements with one of the chambers containing a standard substance (the unsymmetrical case). Results are given of experiments carried out on O, A, and H at the average temperature of 23°C approximately in the unsymmetrical case using air as standard. [English translation in: Instrum. exper. Tekh. (USA), No. 1, 112-16 (Jan.-Feb., 1958; publ. April, 1958)]. S.Weintroub

THERMAL CONDUCTIVITY OF BINARY GAS MIXTURES: KRYPTON–ARGON, KRYPTON–NEON, AND KRYPTON–HELIUM. See Abstr. 10526

10551 MOLECULAR ASSOCIATION IN SODIUM CYANIDE VAPOR. R.F.Porter.
J. chem. Phys. (USA), Vol. 35, No. 1, 318-22 (July, 1961).

Mass spectra of vapours from samples of NaCN indicate that the compound evaporates as NaCN (g) and $Na_2(CN)_2$(g) molecules at temperature around 1000°K. The mass spectrum resembles that obtained for sodium halide and hydroxide vapours. A comparison of relative ion currents produced by electron bombardment of NaCN vapours effusing from single- and double-oven type Knudsen cells, yielded information related to the processes of ion formation. For the reaction

$$Na_2(CN)_2(g) = 2NaCN(g),$$

$\Delta H_{1000^0} = 41.0 \pm 3.0$ kcal/mole dimer is obtained. This indicates a dimer stability comparable to that for Na_2I_2(g).

VACUUM PHYSICS

10552 COMPREHENSIVE STUDY OF THE ION PUMPING OF THE NOBLE GASES. B.Cobic, G.Carter and J.H.Leck
Brit. J. appl. Phys., Vol. 12, No. 6, 288-92 (June, 1961).

The ion pumping of five noble gases by Bayard–Alpert ionization gauges was studied extensively, employing an ultra-high-vacuum system which could be operated statically or dynamically. The dependence of the important pumping parameters, initial pumping speed and maximum quantity of gas pumpable, upon gas composition, electrode potentials and gauge temperature were investigated. The relationship between instantaneous pumping speed and the quantity of gas pumped has been deduced, and observations upon the recovery of gas, following sorption, at ambient and elevated temperatures were also made. It is shown that the experimental results confirm a previously reported model of the sorption process where gas ions enter a heterogeneous collection of capture sites of various energies of binding in the glass walls. The observed form of a static pump-down is interpreted in terms of the kinetic processes which can occur at these sites.

10553 ELECTRICAL MICROMANOMETER. H.R.Hart.
J. sci. Instrum. (GB), Vol. 38, No. 7, 300-2 (July, 1961).

An instrument is described for measuring differential pressure in the range 10^{-4} to 1.0 in. water with high accuracy. Minimum reliable indication of 10^{-6} in. water was obtained in calibration. The instrument is null reading for extreme accuracy, but is also designed for direct recording and portability.

10554 IONIZATION GAUGE FOR TRANSIENT GAS PRESSURE J.D.Cobine and E.E.Burger.
Rev. sci. Instrum. (USA), Vol. 32, No. 6, 717-20 (June, 1961).

A description and operating characteristics of a vacuum gauge

ircuit for the measurement of transient pressures in the range 10^{-4} to 10^{-7} mm Hg are presented. Rise times as short as 10 μsec re obtained with the experimental instrument.

10555 THE TENSIMETER, A NEW VACUUM GAUGE. R.C.Anderson, G.M.Cooke, L.C.Kenyon, Jr and R.L.Mathiasen.
Rev. sci. Instrum. (USA), Vol. 32, No. 7, 780-3 (July, 1961).

The tensimeter was developed to meet the need for a more dependable laboratory vacuum gauge which would be useful over the range of pressures from atmospheric down to a fraction of a millimeter of Hg absolute. The principle of operation involves using the boiling point of a pure compound as a measure of the pressure of the connected system. A description and calibration data are included. The advantages of the tensimeter arise from the fact that it tolerates atmospheric water vapour which is usually present in petroleum distillations and causes other gauges to read incorrectly. It is small and convenient to use and does not require recalibration. It also produces an electrical signal which can be used for recording and control of subatmospheric pressures.

10556 VACUUM SEALING OF GOLD WIRE LEADS TO A DIFFERENTIAL THERMOPILE. F.B.Riggs, Jr.
Rev. sci. Instrum. (USA), Vol. 32, No. 3, 366 (March, 1961).

Gold wires, led through a soapstone plug, into a thermal conductivity cell are vacuum-sealed by Neoprene gaskets pressed against the wires and the plug. It is shown that the homogeneity of the wires, of importance in differential temperature measurements, is unchanged by the sealing operation. G.Carter

10557 ULTRA-HIGH VACUUM SEAL FOR SPACE SIMULATION SYSTEMS. E.E.Brueschke.
Rev. sci. Instrum. (USA), Vol. 32, No. 6, 732-4 (June, 1961).

The operation and construction of a leak-free seal, by means of which limited translational and unlimited rotational motion in a vacuum can be obtained, is described. The seal is accomplished by using a rubber gasket in combination with a liquid which is in equilibrium with internal and external pressure. This seal can be operated from zero to several thousand rev/min and can be used at 10^{-9} mm Hg and lower without difficulty. The seal has distinct advantages for use in space environment simulation chambers and other ultra-high vacuum apparatus.

10558 ALL-METAL VALVE FOR ULTRA-HIGH VACUUM USE. R.B.Thorness and A.O.Nier.
Rev. sci. Instrum. (USA), Vol. 32, No. 7, 807-10 (July, 1961).

A demountable solderless all-metal valve suitable for ultra-high vacuum applications is described. A gasketed stainless steel diaphragm transmits the motion. Valves of several sizes have been constructed. One modification is useful for providing a straight path for passage of a beam of particles or light between chambers which it may be necessary to evacuate separately. A pair of valves in a common block may be used to provide a convenient, accurate metering volume. A group of valves machined from a single block may form a complete manifold. The basic mechanism has also been employed for transmitting motion in a high vacuum system as for adjusting a slit.

HELIUM DIFFUSION THROUGH GLASS. See Abstr. 10010

VIBRATIONS . ELASTIC WAVES

(See also Shock Waves)

10559 EXPERIMENTAL CONFIRMATION OF LAMB WAVES AT MEGACYCLE FREQUENCIES. D.C.Worlton.
J. appl. Phys. (USA), Vol. 32, No. 6, 967-71 (June, 1961).

A theory formulated in 1916 by Horace Lamb predicting that plates may vibrate in up to an infinite number of modes, is confirmed by a method described. The theory is extended to correlate experimental observations. Equations are developed relating phase velocity to frequency and plate thickness in terms of longitudinal and shear wave velocity. Families of curves are obtained for aluminium and zirconium. The distinguishing characteristics of the various modes are discussed in the light of potential nondestructive testing applications. It is shown that the interior particles are displaced in elliptical orbits, with vertical motions existing at the surfaces when the wave velocity is $\sqrt{2}$ shear wave velocity, and horizontal surface motions existing for wave velocities equal to longitudinal wave velocity.

10560 ELASTIC WAVE MODE CONVERSION AT A SOLID–SOLID BOUNDARY WITH TRANSVERSE SLIP. G.J.Kühn and A.Lutsch.
J. Acoust. Soc. Amer., Vol. 33, No. 7, 949-54 (July, 1961).

If two solids are coupled to each other through a liquid layer, transverse slip can occur at the boundary surface when an elastic wave is incident on the boundary. Algebraic expressions for the amplitudes of the various wave modes are derived on the assumption of transverse slip at the boundary, and these are compared with wave mode amplitudes for a solid–air boundary. Experimental measurements in connection with the design of an indicator for the degree of coupling between an angle probe and a test object are explained on this assumption. Curves are given showing wave-mode amplitude for: (i) Plexiglas–air boundary; (ii) Plexiglas–steel boundary assuming transverse slip; (iii) Plexiglas–steel boundary assuming rigid contact.

10561 RAYLEIGH WAVES IN A POROUS, ELASTIC, SATURATED SOLID. J.P.Jones.
J. Acoust. Soc. Amer., Vol. 33, No. 7, 959-62 (July, 1961).

The equation for the velocity of propagation of Rayleigh-type surface waves in a porous, elastic, saturated solid is derived and discussed. The inertia coupling between fluid and solid is neglected, and Darcy's coefficient is taken to be independent of frequency.

MECHANICAL ANALOGUE OF THE ZEEMAN EFFECT. See Abstr. 10302

ACOUSTICS

10562 SOUND RADIATION FROM PROLATE SPHEROIDS. G.Chertock.
J. Acoust. Soc. Amer., Vol. 33, No. 7, 871-6 (July, 1961).

Spheroidal coordinates and wave-functions are used to analyse the sound radiation from a prolate spheroid whose surface vibrates in an arbitrary pattern. Expressions are derived for the pressure distribution, velocity amplitude, radiation impedance, and directivity factor in each spheroidal radiation mode. Numerical results are derived for two special examples: (1) a rigid-body vibration of a thin spheroid, and (2) an "accordion-like" vibration of a thin speroid.

10563 GENERATION OF INTENSE AUDIO SOUND FIELDS UTILIZING ARRAYS OF MULTIPLE-DRIVER HORNS. S.E.Levy and R.W.Carlisle.
J. Acoust. Soc. Amer., Vol. 33, No. 7, 936-40 (July, 1961).

There are several major applications for intense audio sound fields: the outdoor propagation of speech and of warning signals, and the sonic fatigue testing of missile and aircraft components. In these applications, several factors combine to make it necessary to limit the portion of the frequency spectrum covered by any one loudspeaker unit. In order to provide adequate power capacity, selection is required between the alternatives of (a) using a large number of identical drivers, (b) using a plurality of drivers each especially designed for a selected portion of the frequency range, and (c) using combinations of these arrangements. In an array currently being used for sonic-fatigue testing, a plurality of large open-cone loudspeakers is used for low frequencies, and a plurality of horns is used for middle and high frequencies. Each horn is driven by several drivers. The driver voice coil and diaphragm proportions have been optimized to withstand fatigue stresses under the thermal conditions encountered. The driver is rated at 50 W input for programme material. Horn assemblies are available having throat arrays for mounting 6, 12, or 24 drivers. Various applications are illustrated.

10564 IMPROVED NICKEL-BASE ALLOYS FOR MAGNETOSTRICTIVE TRANSDUCERS. C.A.Clark.
J. Acoust. Soc. Amer., Vol. 33, No. 7, 930-3 (July, 1961).

Dynamic magnetostrictive properties were measured for nickel-base alloys containing up to 10% cobalt, with from 0 to 6% chromium. The maximum value of electromechanical coupling coefficient (0.51) occurs in a binary alloy containing 4.5% cobalt, balance nickel, for which the magnetocrystalline-anisotropy constant is zero. The maximum value of potential electroacoustic efficiency for resonance frequencies below 100 kc/s is found, however, in a ternary alloy containing 1.4% cobalt, 2.3% chromium, balance nickel. It is concluded that the binary alloy is the most suitable material for the magnetostrictive element of receivers, such as hydrophones,

particularly where a reasonably flat response is sought. The ternary alloy, because of its lower eddy-current losses, is to be preferred for generating high-frequency acoustic power.

10565 MECHANICAL PRESSURE-GRADIENT-TO-PRESSURE SOUND TRANSDUCER.
T.F.W.Embleton and G.J.Thiessen.
J. Acoust. Soc. Amer., Vol. 33, No. 7, 933-5 (July, 1961).

In places of high ambient-noise level, the use of electrical devices as an aid to speech communication is sometimes precluded by safety requirements. A mechanical device may then be used provided that the individuals concerned are close to each other. Such a device can be made to incorporate all the acoustical benefits of a close-talking microphone. Sentence intelligibility tests showed that when the articulation index was zero for a nearby speech source the median subject obtained a score of 28% using ear covers alone and 84% with the sound transducer; the subjects with extreme scores improved from 0 to 14% and from 88 to 100% respectively. No subject using the device suffered a decrease in intelligibility.

10566 THE COMPUTATION OF FAR-FIELD RADIATION PATTERNS FROM MEASUREMENTS MADE NEAR THE SOURCE. C.W.Horton and G.S.Innis, Jr.
J. Acoust. Soc. Amer., Vol. 33, No. 7, 877-80 (July, 1961).

An analysis is made of two methods of predicting the far-field radiation pattern from pressure measurements made over a closed surface S, containing the source. One of these methods involves the use of Green's functions and yields two subcases according to the particular Green's function that is used. The Helmholtz formula, which results when one uses a Green's function of the form $\exp(ikR)/R$, requires the knowledge of the normal gradient of the pressure, $\partial p/\partial n$, over S in addition to the pressure p, but it leads to a formula that is relatively easy to evaluate. An approximation to $\partial p/\partial n$ is discussed. If, instead, one uses the Green's function which vanishes over the surface S, one can evaluate the pressure in the far field, in terms of measurements over S, of p only. The resulting formula is somewhat more complicated than the Helmholtz formula, but it does not require a knowledge of $\partial p/\partial n$. The second method is based on a proposal recently made by Pachner. It is shown, for the case of prolate spheroidal coordinates, that Pachner's method is completely equivalent to the second approach mentioned above. The applicability of these formulae is demonstrated with experimental data for a line hydrophone. Good agreement is obtained between the experimental radiation pattern and the theoretical patterns predicted by formulae.

10567 ARRAY STEERING IN A LAYERED WAVEGUIDE. C.S.Clay.
J. Acoust. Soc. Amer., Vol. 33, No. 7, 865-70 (July, 1961).

The usual way to determine the direction of a radiating source with an array is to steer the array for maximum output. The steering can be done by time delays or by mechanically turning the array. The output of the array can be expressed as the sum of the time average of the products of the pressure $\langle P_m P_n \rangle$, observed at at detectors m and n. The value of $\langle P_m(\tau_m) P_n(\tau_n) \rangle$ can be maximized by a proper choice of time delays τ_m, τ_n. This procedure is straightforward in an infinite homoegenous medium. If the medium is a layered waveguide, there are many more possibilities for submaxima of the $P_m P_n$ terms. The normal mode solution of the radiation field of a band-limited noise point source is used to calculate the acoustical pressures P_m and P_n. The value of $\langle P_m(\tau_m) P_n(\tau_n) \rangle$ as a function of time delay is compared with the value of $P_n P_m$ obtained with mechanical steering. For these calculations, the noise source is assumed to have a bandwidth of one fifteenth of the centre frequency, and the depth of the water is assumed to be about 2λ over a thick layer of unconsolidated sediment. The number of maxima of the $\langle P_m(\tau_m) P_n(\tau_n) \rangle$ is related to the number of modes propagating in the waveguide if the steering is done with time delays. Mechanical steering yields one maximum that corresponds to the source direction.

10568 THEORETICAL AND EXPERIMENTAL STUDY OF UNDERWATER SOUND REVERBERATION.
B.F.Cron and W.R.Schumacher.
J. Acoust. Soc. Amer., Vol. 33, No. 7, 881-8 (July, 1961).

A theoretical study of the fluctuation of the amplitude and phase associated with the return of a single frequency pulse was made. A vectorial representation was used. From this model the conditions necessary for first-order Rayleigh distribution of amplitudes are given. Experimental tests were conducted in the Bermuda area. Data on volume reverberation, as well as surface return and surface plus bottom return, were obtained. The data were processed via the USL Datrac–Datatron system. Analogue as well as digital processing was used. An analogue electronic circuit was used to generate the Hilbert transform of the returned signal. The return signal and the Hilbert transform were both sampled by the "Datrac" system at a rate of the reciprocal of the band-width. The analogue values thus obtained were then converted to digital form by the "Datrac" system. From the digital values of the original time function and the Hilbert transform of the time function, the Datatron 205 was programmed to compute the corresponding values of the envelope and the phase of the carrier frequency. Experimental histograms were obtained by the computer for these values. The experimental histograms were compared with the expected theoretical distributions. Statistical tests of goodness of fit were conducted on these data. The results showed the theoretical assumptions to be valid.

10569 SOLUTION OF AN INTEGRAL EQUATION OCCURRING IN THE STUDY OF CERTAIN WAVE-PROPAGATION PROBLEMS IN LAYERED MEDIA. I.M.Longman.
J. Acoust. Soc. Amer., Vol. 33, No. 7, 954-8 (July, 1961).

This paper describes a method of inversion of an integral equation arising in the solution of the problem of reflection or refraction of a spherical sound-wave pulse at a plane interface in a layered elastic medium. The solution of this integral equation is equivalent to obtaining the inverse Laplace transform of the operational solution of the problem.

10570 SPECTROSCOPIC INVESTIGATION OF THE PROPAGATION OF HYPERSONIC VIBRATIONS IN VISCOUS LIQUIDS. M.S.Pesin and I.L.Fabelinskii.
Dokl. Akad. Nauk SSSR, Vol. 135, No. 5, 1114-16 (Dec. 11, 1960). In Russian.

For abstract, see Abstr. 8183 of 1961. [English translation in: Soviet Physics–Doklady (USA), Vol. 5, No. 6, 1290-2 (May-June, (1961)].

SOUND VELOCITY IN INDIUM AT LOW TEMPERATURES. See Abstr. 9974

A STUDY OF ACOUSTIC PROPERTIES OF SUBMERGED SOIL AT HIGH FREQUENCIES. See Abstr. 10301

10571 MULTIPLE SCATTERING OF WAVES. P.C.Waterman and R.Truell.
J. math. Phys. (USA), Vol. 2, No. 4, 512-37 (July-Aug., 1961).

Multiple scattering effects due to a random array of obstacles are considered. Employing a "configurational averaging" procedure, a criterion is obtained for the validity of approximate integral equations describing the various field quantities of interest. The extinction theorem is obtained and shown to give rise to the forward-amplitude theorem of multiple scattering. In the limit of vanishing correlations in position, the complex propagation constant κ of the scattering medium is obtained. Under appropriate restrictions, the expression for κ is shown to include both the square-root law of isotropic scatterers and the additive rule for cross sections valid for sufficiently low densities of anisotropic obstacles. Some specific examples from acoustics and electromagnetic theory then indicate that at least in the simplest cases the results remain valid for physically allowable densities of obstacles.

10572 STRESS WAVE PROPAGATION AS APPLIED TO THE DETECTION OF FLAWS BY ULTRASONIC DETECTION. D.G.Christie.
Progress in non-destructive testing. Vol. 1 (see Abstr. 9238 of 1961) p. 33-56.

The theoretical basis of the pulse echo technique of ultrasonic flaw detection is considered. Topics treated include the ultrasonic pulse, its method of propagation, scattering of the pulse, reflection and refraction at boundaries, effects of thin layers at interfaces, and the pressure amplitude distribution in the incident ultrasonic beam. There are 20 references. J.B.Birks

USE OF ULTRASOUND IN WELDING OF COPPER. See Abstr. 10359

DIFFRACTION OF LIGHT BY ULTRASONIC WAVES OF VARIOUS STANDING WAVE RATIOS. See Abstr. 10601

THE EFFECT OF ULTRASOUND ON CATALYTIC PROPERTIES OF MnO_2 GELS AND SUSPENSIONS. See Abstr. 10296

nstruments and Measurements

10573 THE PROBLEM OF THE REVERBERATION METHOD SOLVED? C.W.Kosten.
.custica (Internat.), Vol. 10, No. 2, 126-7 (1960).

A preliminary report is given on an extensive series of tests f the reverberation method for the measurement of sound bsorption coefficients which were made by some 20 organizations roughout the world. Four criteria should be met for reliable esults: (a) square sample 10m² in one area, (b) room volume not ess than 200m³, (c) a highly diffuse sound field and (d) a standard ay of covering the edges of the sample. Proposals for further tudy are made. H.D.Parbrook

10574 PLANE CONDENSOR ELECTROSTATIC ACTUATORS. G.B.Madella.
Acustica (Internat.), Vol. 10, No. 2, 128 (1960).

A letter proposing the use of a plane electrostatic actuator with a guard ring for the low frequency calibration of "flat-topped" condenser microphones. A "large" air gap between the actuator and diaphragm was used. The calibration errors were not greater than 0.2 to 0.3 dB. H.D.Parbrook

OPTICS . PHOTOMETRY

10575 SOME PROPERTIES OF COHERENT LIGHT. L.Mandel and E.Wolf.
J. Opt. Soc. Amer., Vol. 51, No. 8, 815-19 (Aug., 1961).

The present is concerned with the study of some general properties of coherent light. A clear definition of coherence is given, which appears to be preferable to definitions previously proposed by other authors. Several new theorems relating to correlation functions and the spectral density functions of coherent light are derived. The results are used to establish the Huygens—Fresnel principle for a coherent optical field. This principle has previously been freely applied to such a field, although the validity of the principle has only been justified for the much more idealized (and physically unrealizable) case of a field which is strictly monochromatic. The present formulation of the Huygens—Freshel principle involves only observable quantities and not the instantaneous amplitudes and the instantaneous phases of the light vibrations.

10576 NEW PHOTOMETER FOR VISUAL HETEROCHROMATIC PHOTOMETRY. L.J.Boardman.
J. Opt. Soc. Amer., Vol. 51, No. 8, 905-8 (Aug., 1961).

A new heterochromatic photometer was devised that combines the features of the direct-comparison and the flicker methods. Two contiguous photometric fields (for example, red and blue) are viewed in a plane mirror which is pivoted at one end and oscillates approximately 2^0 at a frequency of 5 to 40 c/s. Each left or right movement of the mirror is of constant velocity. This mirror oscillation causes the image of the vertical boundary between the two fields to oscillate and blur into a central zone in which the two colours are mixed. The mixed zone has a colour graduation with the colours at its two boundaries the same as the adjacent fields, and a photometric match is achieved when the luminance becomes uniform and both boundary lines disappear. The disappearance of both boundary lines has proved to be more precise indication than the disappearance of flicker in the central zone. Various tests, using both experienced and inexperienced observers, showed that in both ease of use and precision the new method is superior to the direct-comparison and the flicker methods. These tests involved field luminances from 32.50 candles/ft² to 0.0011 candles/ft².

AUTOMATIC ELECTROPHOTOMETRIC RECORDING OF NIGHT-SKY LUMINANCE. See Abstr. 10330

GEOMETRICAL AND INSTRUMENTAL OPTICS SPECTROSCOPY

(Optical spectra and their analysis are included under the appropriate heading, e.g. Atoms, Molecules, Solid-State Physics, etc.)

ARRANGEMENT OF MIRRORS TO FORM MULTIPLE REFERENCE ANGLES. See Abstr. 10472

FABRY—PEROT ETALON FOR INFRARED REFRACTOMETRY OF LIQUIDS. See Abstr. 10599

10577 FITTING REFRACTIVE INDEX DATA BY LEAST SQUARES. L.E.Sutton and O.N.Stavroudis.
J. Opt. Soc. Amer., Vol. 51, No. 8, 901-5 (Aug., 1961).

The accessibility of high-speed computing machinery makes practicable the use of a routine for the least-squares fitting of a three-term Sellmeier equation to a set of experimentally determined values of index of refraction. The constants of a two-term Sellmeier equation are evaluated by a method described previously (see Abstr. 9470 of 1961). These are then used in a preliminary fitting of another term. The rough fit is then improved by an iterative process which includes an acceleration technique to speed convergence to the final result. In a typical example the average residual of index is only about 2×10^{-6} for 46 wavelengths from 0.2652 μ to 10.346 μ.

10578 EFFECTS OF NUMERICAL APERTURE ON CONTRAST IN ORDINARY MICROSCOPY.
H.Osterberg and L.W.Smith.
J. Opt. Soc. Amer., Vol. 51, No. 7, 809-14 (July, 1961).

Experiments in which the numerical apertures of the objective and condenser of an ordinary microscope are reduced progressively and alternately in a systematic manner are described as regards contrast in the images of nonabsorbing particles that differ slightly from their surrounding medium in optical path. The observed contrast remains poor as the numerical apertures of the objective and condenser are reduced by means of variable diaphragms such that the ratio s of the numerical aperture of the condenser to that of the objective is held at unity. The observed contrast in the images of platelike particles tends toward similarity for a given value of s as the size of particle is increased. The various observations are interpreted theoretically and found to be in qualitative agreement with theory. Conditions under which distributions of irradiance in the images of different platelike particles become similar are formulated for in-focus and out-of-focus image planes. Knowledge of these conditions leads to improved understanding of the effects of numerical aperture on contrast in the image.

10579 BROAD-BAND ULTRAVIOLET FILTERS. C.B.Childs.
J. Opt. Soc. Amer., Vol. 51, No. 8. 895-9 (Aug., 1961).

Three broad-band ultraviolet filters with effective wavelengths of 2680, 2600, and 2210 A are described. The respective transmittances at these wavelengths are 0.16, 0.23, and 0.10, with corresponding bandwidths of 320, 200, and 330 A. The materials used in constructing these filters were: interference filters, $NiSO_4(H_2O)_6$ crystals, KCl:KBr:Pb crystals, Corning filters 9-54 (96% silica), Corning filters 7-54 (red-purple corex A), and cation-X (2, 7-dimethyl-3, 6-diazacyclohepta-1, 6-diene iodide in polyvinyl alcohol films).

10580 INFRARED FILTERS OF ANTIREFLECTED Si, Ge, InAs, AND InSb. J.T.Cox, G.Hass and G.F.Jacobus.
J. Opt. Soc. Amer., Vol. 51, No. 7, 714-18 (July, 1961).

Vacuum deposited single-, double-, and triple-layer infrared antireflection coatings for Si, Ge, InAs, and InSb were developed for the 1 to 15 μ region. MgF_2, didymium fluoride, SiO, ZnS, CeO_2, and Si were used to prepare the coatings. All are hard and durable and can be cleaned and boiled in water for several hours with little or no damage. With these coatings, the transmittance of Si and Ge plates can be increased to a maximum value of nearly 100%, and stays above 90% over a wavelength interval the limits of which are in the ratio of 1.5 : 1, 2.7 : 1, and 3 : 1 for single-, double-, and triple-layer coatings, respectively. InAs and InSb are slightly ab-

sorbing, but more than 90% transmittance can be obtained with sufficiently thin antireflected plates. The temperature dependence of absorption in all four of these materials has been measured in the range from 25° to 250°C.

10581 ON A GENERAL THEOREM IN INTERREFLECTION THEORY WITH APPLICATION TO THE FLUORESCENT LAMP. M.A.Weinstein.
J. Opt. Soc. Amer., Vol. 51, No. 7, 723-6 (July, 1961).

A general theorem is established concerning the effect of a transmitting hole on the lumen output of an otherwise uniform, diffuse enclosure with light-generating walls. The physical content of the theorem is first, that when a small hole is opened one loses, to first order in the area of the hole, the flux which was emitted to the outside from this area, but gains $(1-R)^{-1}$ times the flux which was absorbed in this area, where R is the reflectance of the enclosure wall; and second, that if opening an infinitesimal hole decreases the output, then opening any hole, no matter what its size, shape or position, will also decrease the output. From this it follows that opening a hole can increase the output of the enclosure if and only if the absorptance of the enclosure wall exceeds a certain critical value; the critical absorptance is calculated explicitly, and is shown to be independent of the geometry of both the enclosure and the hole. As an application, it is shown that the absorptance of standard fluorescent lamp coatings is very much smaller than the critical absorptance, and hence that if any part of the envelope of such lamps is left bare, the output and efficiency will be decreased.

10582 CYLINDRICAL APERTURE LAMPS. D.E.Spencer and L.L.Montgomery.
J. Opt. Soc. Amer., Vol. 51, No. 7, 727-30 (July, 1961).

Describes a new type of fluorescent lamp which is brighter than any previous fluorescent lamp. A major part of the light emitted from the phosphor is radiated through a narrow, transparent aperture. The gain is effected entirely by multiple reflections within the lamp, without requiring any additional power input. The paper presents the fundamental integral equations for interflections within the lamp and their solution in an important special case. Graphs of photometric characteristics illustrate the potentialities of aperture lamps. Data are also presented on the characteristics of experimental aperture lamps.

10583 POLARIZATION, GHOST, AND SHADING EFFECTS IN DICHROIC BEAM SPLITTERS. D.Levine and G.J.Monser.
J. Opt. Soc. Amer., Vol. 51, No. 7, 783-9 (July, 1961).

The reflective qualities of a dichroic beam-splitter are dependent upon the polarization and angle of incidence of the incident light. Consequently, when the incident light has equal horizontal and vertical components, the same is not true of the transmitted and reflected light. Utilization of the polarization properties is described for a camera periscope on a cathode-ray tube display employing an exposure meter. The polarization and other characteristics of a ghost image arising from reflection at the second surface of the beam-splitter also are examined. The mean angle of incidence is a complicated function of the distance of the source from the optical axis, the radius of the entrance pupil, and the distance to the reflector. For purposes of discussion, two specific values are indicated for every emitter located farther from the optical axis than the radius of the entrance pupil. When the reflectance is a function of the angle of incidence at wavelengths emitted by the phosphor, the variation of the angle of incidence with azimuth angle introduces a change in reflected flux for uniform excitation of the cathode-ray tube; that is, the dichroic mirrors are a source of shading in the reflected image.

10584 TELESCOPE FOR MEASUREMENT OF OPTIC ANGLE OF MICA. S.Ruthberg.
J. Res. Nat. Bur. Stand. (USA), Vol. 65C, No. 2, 125-8 (April-June, 1961).

The described instrument allows rapid measurement of the apparent optic angle to an accuracy of 5′ of arc for samples as large as 2 in. in diameter. This angle is a property pertinent to the quality of mica. Instrumentation is quite simple but dependent upon the complex phenomena of interference figures produced by biaxial crystals in polarized light. Magnification is great, dispersion can be determined, and the uniformity of samples can be observed.

10585 ALKALI METAL VAPOR SPECTRAL LAMPS. W.E.Bell, A.L.Bloom and J.Lynch.
Rev. sci. Instrum. (USA), Vol. 32, No. 6, 688-92 (June, 1961).

Efficient electrodeless discharge spectral lamps that are suitable for transmission monitoring of optically polarized quantu systems were developed. The lamps have a surface brightness close to the theoretical limit with substantially no self-reversal. The limiting intensity fluctuations observed appear to be that of photon shot noise. Predicted life of the lamp is in excess of 5000 h

10586 HIGH-RESOLUTION KINETIC SPECTROSCOPY BY A MULTIPLE-FLASH METHOD. H.H.Kramer, M.H.Hanes and E.J.Barr.
J. Opt. Soc. Amer., Vol. 51, No. 7, 775-9 (July, 1961).

Experiments are described in which double-beam absorption measurements are made at high spectral resolution (better than 0.05 A in the visible and near ultraviolet) at an accurate sequence of time intervals as short as 200 μsec. This is accomplished with a high-resolution monochromator and dual-photomultiplier detecto using a stroboscopic xenon flash source. Signals representing the absorption ratios are recorded on magnetic tape and read out with digital integrator. A quantitative test of this procedure was made by observing the iodine recombination reaction following flash pho lysis. The accuracy of the results compares favourably with previous measurements which have used spectral bandwidths a thousa times broader. The use of this method for measuring rates of fre radical reactions is described using observations of NH_2 radicals an illustration.

10587 THE INVERSION OF ZEEMAN SPLIT LEVELS. F.V.Bunkin.
Radiotekhnika i Elektronika (USSR), Vol. 4, No. 5, 886-90 (May, 19 In Russian.

The effect of transverse magnetic field perturbations on the inversion of Zeeman split levels for reversals of the longitudinal field is considered. Estimates are obtained of the required velocit of the particles of the system such that, for a given type of field reversal, the transverse fields will not produce any transitions. The result is of practical interest in connection with the use of thi method for obtaining active molecules for molecular amplifiers.
R.C.Gla

10588 THE SPEED OF INVERSION OF ZEEMAN SPLIT LEVELS. M.I.Rodak.
Radiotekhnika i Elektronika (USSR), Vol. 4, No. 5, 891 (May, 1959) In Russian.

It is shown that the results obtained by Bunkin (see preceding abstract) can be obtained somewhat more simply without using quantum-mechanical considerations, by interpreting the condition of non-adiabaticity of the perturbation of the field in a somewhat different way.
R.C.Gla

10589 PHOTODETECTING INSTRUMENT WITH FLAT WAVE LENGTH RESPONSE. P.M.McPherson, N.Sclar, B.R.Linden, W.Brouwer and A.T.Stair, J
J. Opt. Soc. Amer., Vol. 51, No. 7, 767-73 (July, 1961).

Photosensitive instruments which measure absolute irradianc in four spectral bands (2000-2500 A, 2500-4000 A, 4000-5000 A, a 5000-10 000 A) are described. One instrument is used to cover ea range. The basic unit is a prism-type spectrometer that weighs 2 lb and measures $1\frac{1}{2}$ by 15 in. This compact packaging is achieve by the use of a unique single prism that produces a straight-throu optical axis. The spectral cutoffs are sharp and the electrical out put is constant for a given flux of any wavelength distribution with the spectral passband. The passband with sharp wavelength cutoff and a flat response versus wavelength is accomplished by the use a mask with variable aperture placed in the focal plane. Micro-second response time is obtained through the use of a $\frac{3}{4}$ in. photo-tube detector which is used as a photomultiplier or photodiode, depending upon sensitivity requirements.

10590 RAPID SCAN INFRARED SPECTROGRAPH WITH LINEAR WAVELENGTH PRESENTATION. J.F.Porter, Jr.
J. Opt. Soc. Amer., Vol. 51, No. 7, 789-93 (July, 1961).

A spectrometer has been developed which scans the infrared spectrum from 1 μ to 5.5 μ in 15 msec, 20 times/sec. The spectr are recorded on 35 mm film with a linear wavelength presentation The instrument was developed from the modification of a Perkin–Elmer model 99 monochromator. Principal emphasis is given to

he development of a linear wavelength presentation with a method ndicated for correcting the amplitude of the recorded spectra for ll nonlinearities.

10591 HOLMIUM FILTER FOR CHECKING THE WAVELENGTH SCALE OF RECORDING SPECTROPHOTOMETERS. J.M.Vandenbelt.
J. Opt. Soc. Amer., Vol. 51, No. 7, 802-3 (July, 1961).

A Corning ultraviolet-transmitting glass incorporating Ho has seven sharp absorption bands in the ultraviolet and four in the visible spectrum, providing stable wavelength standards.

S.T.Henderson

10592 A DOUBLE-PASS SPECTROMETER. T.K.McCubbin, Jr.
J. Opt. Soc. Amer., Vol. 51, No. 8, 887-9 (Aug., 1961).

An optical system for obtaining doubly passed grating and prism spectra is described and its application to infrared spectroscopy is discussed. The optical system consists of a spherical field mirror which is placed in the focal plane of the spectrometer and a spherical re-imaging mirror which receives radiant energy from the field mirror. Features of the new system are ease of adjustment and freedom from vignetting. The system has been set up and tested both in a high-resolution grating spectrometer and in a low-resolution order-sorting prism instrument.

10593 SPECTROPHOTOMETRIC ATTACHMENT FOR THE VACUUM ULTRAVIOLET. N.N.Axelrod.
J. Opt. Soc. Amer., Vol. 51, No. 8, 898-900 (Aug., 1961).

An absorption spectrophotometric attachment to a vacuum ultraviolet monochromator was built and tested. With an empty sample chamber, the ratio of the radiant flux through the sample chamber to the radiant flux through the reference chamber was measured. By optimizing conditions at the entrance slit, the ratio was constant within experimental error over the region 1000-1600 A. The transmittance of thin celluloid films was measured with the attachment.

10594 LOW TEMPERATURE ULTRAVIOLET CELL. C.J.Aloisio.
Rev. sci. Instrum. (USA), Vol. 32, No. 4, 452 (April, 1961).

An absorption cell of simple design for use in ultraviolet spectrophotometry with a Beckman DK ratio-recording spectrophotometer is described. It consists of an inner and an outer chamber separated by an evacuated region for thermal insulation. The cell is constructed from steel tubing and a machined stainless steel block. Its base dimensions are 11 × 11 cm. R.W.Nicholls

10595 FUSED SALT SPECTROPHOTOMETRY. I. FURNACES FOR A CARY MODEL 14 SPECTROPHOTOMETER. J.R.Morrey and A.W.Madsen.
Rev. sci. Instrum. (USA), Vol. 32, No. 7, 799-801 (July, 1961).

Furnaces which can be readily installed or removed from the sample and reference compartments of an unmodified Cary model 14 spectrophotometer are described in some detail. Heat requirements to 800° C are given for these units.

10596 METHODS AND TOOLS FOR THE REDRAWING OF SPECTRAL DIAGRAMS. G.Bergmann and H.Kaiser.
Z. Instrumkde (Germany), Vol. 68, No. 9, 201-7 (Sept., 1960). In German.

Describes an apparatus for photographic reproduction of curves of spectral absorption, it being possible to change the scale of both axes to produce a standard size of diagram. The wavelength (or wavenumber) scale may be reproduced as its reciprocal.

G.F.Lothian

PHYSICAL OPTICS

(Luminescence is included under Solid-State Physics, Liquid State, or Gaseous State)

10597 HOMOGENEOUS–INHOMOGENEOUS THIN-FILM COMBINATIONS. S.F.Monaco.
J. Opt. Soc. Amer., Vol. 51, No. 8, 855-8 (Aug., 1961).

By using the matrix-theory approach, an exact formula for the reflectance of light incident normally on a non-absorbing, thin-film combination made of homogeneous and inhomogeneous films is derived. The refractive indexes of the inhomogeneous layers change exponentially with film thickness, and the combination is bounded on either side by non-absorbing, homogeneous, semi-infinite media. The formula, which is valid for any wavelength, has been analysed at short and long wavelengths.

THE REDUCTION OF OPTICAL REFLECTION BY COATING GERMANIUM PHOTORESISTORS, WITHOUT INCREASING THE RATE OF SURFACE RECOMBINATION. See Abstr. 10068

10598 QUANTUM THEORY OF INTERFERENCE EFFECTS IN THE MIXING OF LIGHT FROM PHASE-INDEPENDENT SOURCES. U.Fano.
Amer. J. Phys., Vol. 29, No. 8, 539-45 (Aug., 1961).

Correlations in space and time of the light intensity from extended sources, observed by Brown and Twiss and by Forrester (1954-56), were analysed by these authors primarily in terms of field oscillations. This paper discusses an atomic process which brings out the intensity correlations, namely, the photoionization of a pair of atoms following photon emission by another pair of independently excited atoms. The calculated probability of this process depends sinusoidally on the relative positions of the four atoms and also, when the source atoms emit different frequencies, on the time interval between the photoionizations, in agreement with the macroscopic treatment. The oscillations arise from an interference of probability amplitudes which is not affected by the random phases of the source atoms. The calculation follows a standard approach but involves some novel detail.

10599 BISMUTH-COATED FABRY–PEROT ETALON FOR USE ON THE 2.5-10 μ REGION. R.E.Kagarise.
J. Opt. Soc. Amer., Vol. 51, No. 8, 830-3 (Aug., 1961).

A Fabry–Perot etalon, employing bismuth-coated CaF_2 plates, was constructed for measuring the dispersion of liquids in the infrared region. The reflectivity of bismuth is sufficiently high to give fringes of high constrast. In order to take advantage of this improved fringe sharpness, a grating spectrometer was used to measure the wavelength of the maxima. Because of a non-ideal phase shift, it was necessary to apply an empirically determined correction to the normal integral orders of interference. By using this approach it has been possible to measure the refractive index of CS_2 with a relative accuracy of about ±0.001.

10600 AN AUTOMATIC FRINGE COUNTING INTERFEROMETER FOR USE IN THE CALIBRATION OF LINE SCALES. H.D.Cook and L.A.Marzetta.
J. Res. Nat. Bur. Stand. (USA), Vol. 65C, No. 2, 129-40 (April-June, 1961).

A reversible fringe counting interferometer is described in which mechanical, optical, and electronic adjustments are maintained stable by servomechanism control or by balancing. Mirror parallelism is achieved by detecting the angular error electronically and correcting by means of barium titanate actuators. An electronic interpolator permits recording of the count in digital form to 0.01 fringe without ambiguity. A rate of more than 1200 fringes/sec was achieved over a range of 14 cm. Higher counting rates are possible over shorter ranges. Design factors and details are discussed. A correction factor is derived for the error introduced by finite collimation of the interferometer beam.

10601 DIFFRACTION OF LIGHT BY ULTRASONIC WAVES OF VARIOUS STANDING WAVE RATIOS. B.D.Cook and E.A.Hiedemann.
J. Acoust. Soc. Amer., Vol. 33, No. 7, 945-8 (July, 1961).

The theory for the diffraction of light by plane ultrasonic waves of various standing wave ratios is derived. The liquid medium disturbed by the ultrasound is considered to act as an optical phase grating. By evaluating the diffraction integral for the light amplitude, expressions for the Doppler shift, the time-dependent, and the time-average light intensities are found for the diffraction spectrum. Experimental measurements using two adjacent ultrasonic waves progressing in opposite directions to simulate the desired optical phase grating indicate that the theory is valid.

10602 ROLE OF END-FIRE AND BROADSIDE RADIATION IN REFRACTION, DISPERSION, AND SUPERGAIN. A.F.Wickersham, Jr.
J. Opt. Soc. Amer., Vol. 51, No. 7, 730-6 (July, 1961).

By allowing complex angles of incidence and scattering in the grating equation, several types of surface modes are obtained. One

of these is a forced surface wave associated with "end-fire", and another is a "broadside" mode. Experimental data are shown which correlate these modes with dispersion phenomena in periodic dielectrics. The introduction of imaginary angles in scalar optics theory is shown to give a prediction of recent experimental supergain data.

10603 LIGHT PRESSURE ON A DIFFRACTING EDGE. R.List and D.Pfirsch.
Z. Phys. (Germany), Vol. 162, No. 5, 421-5 (1961). In German.
The lateral diffraction of light by a perfectly conducting semi-infinite plane should give rise to a tangential light pressure at the edge. This paper presents a quantitative evaluation of the effect. T.Erber

10604 APPLICATION OF THE METHOD OF SPHERICAL HARMONICS TO ANISOTROPIC DIFFUSION [OF LIGHT]. J.Lenoble.
C. R. Acad. Sci. (France), Vol. 252, No. 14, 2087-9 (April 5, 1961). In French.
The transport of light by a plane parallel anisotropically diffusing slab can be treated by expressing the diffusion indicatrix in Legendre polynomials, when the luminance is obtained as an expansion in spherical harmonics. W.T.Welford

10605 PHOTOELECTRIC MEASUREMENT OF POLARIZED LIGHT BY MEANS OF AN A.D.P. POLARIZATION MODULATOR. I. PHOTOELECTRIC POLARIMETER. H.Takasaki.
J. Opt. Soc. Amer., Vol. 51, No. 4, 462-3 (April, 1961).
A brief account is given of a polarimeter using an ADP crystal as a polarization azimuth vibrator of the Senarmont type. The polarimeter has an accuracy of about 1 min. of arc. R.W.Fish

10606 PHOTOELECTRIC MEASUREMENT OF POLARIZED LIGHT BY MEANS OF AN A.D.P. POLARIZATION MODULATOR. II. PHOTOELECTRIC ELLIPTIC POLARIMETER. H.Takasaki.
J. Opt. Soc. Amer., Vol. 51, No. 4, 463 (April, 1961).
The two parameters of elliptically polarized light can be measured simultaneously by the use of two ADP polarization modulators. A polarimeter devised for the study of the optical constants of metals is briefly described. R.W.Fish

10607 BIREFRINGENT COMPENSATOR FOR STUDYING VERY SMALL CHANGES IN DOUBLE REFRACTION. T.S.Narasimhamurty and M.Ziauddin.
J. Opt. Soc. Amer., Vol. 51, No. 5, 574-8 (May, 1961).
A new optical method of studying the dispersion of the photoelastic constants of glasses is described. Experimental results on a specimen of glass are compared with those obtained by Filon's method. The sensitivity of the method is discussed. The applicability of the birefringent compensator method to the study of the dispersion of photoelastic constants of uniaxial and biaxial crystals is indicated.

10608 AUTOMATIC MAGNETO-OPTIC ROTATION TESTER. T.Lentz and J.Miyata.
J. Opt. Soc. Amer., Vol. 51, No. 8, 890-4 (Aug., 1961).
A electromechanical device developed to measure quickly the angle of magneto-optic rotation of a light beam reflected from a thin film of metal. Various experimental arrangements for this purpose have been made in laboratories in the past; however, these have required laborious procedures on each sample that is to be tested and were somewhat inflexible. This paper describes an instrument constructed specifically for magneto-optic measurements, and also discusses some of the phenomena that can be examined by its use. The instrument alternately displays the light-output/analyser-angle curves for the two magnetization states on an oscilloscope. The repetition rate is high enough that the two curves appear to be displayed simultaneously. (The longitudinal Kerr effect, which is the principal object of study here, provides rotations of less that 1.0° and typically on the order of 0.1°.) The time required to evaluate any film by visual observation of the scope traces with an accuracy of about 0.01° is approximately one minute, measurements to 0.005° can be made by using an oscilloscope camera.

10609 PHOTOELECTRIC METHODS OF MEASURING CIRCULAR DICHROISM. J.Badoz, M.Billardon and J.P.Mathieu.
C. R. Acad. Sci. (France), Vol. 251, No. 15, 1477-9 (Oct. 10, 1960). In French.

COLORIMETRY . PHOTOGRAPHY

10610 MUNSELL VALUE/SURFACE REFLECTANCE RELATIONSHIPS. J.Longmore and P.Petherbridge.
J. Opt. Soc. Amer., Vol. 51, No. 3, 370-1 (March, 1961).
The relation $R = V(V-1)$ between Munsell value (V) and surface reflectance (R) is suggested as an approximation for mental calculation. It gives R within ± 1% over a wide range. W.T.Welfor

10611 GRAPHIC EXPRESSION OF LIGHTNESS IN THE FRIEL SYSTEM. E.Friel.
J. Opt. Soc. Amer., Vol. 51, No. 6, 699-702 (June, 1961).
A scale for estimating the lightness of colorants, based on a differential threshold scale obtained with neutral tints. R.S.Weal

10612 SPURIOUS RESOLUTION BY IMAGE MOTION. M.R.Nagel.
J. Opt. Soc. Amer., Vol. 51, No. 7, 780-3 (July, 1961).
A case of complex spurious resolution in airborne photograph resolution tests is studied and explained by establishment of the exposure distribution in the motion-blurred image of a triple-strip white-on-black resolution target. The conditions in black-on-white targets and in targets with n strips are also discussed.

HEAT . RADIATION

10613 THERMAL BEHAVIOR IN VACUUM ZONE REFINING. D.K.Donald.
Rev. sci. Instrum. (USA), Vol. 32, No. 7, 811-13 (July, 1961).
The temperature distribution and the total radiated power are computed for a bar undergoing zone refining in vacuum, using a one-dimensional analysis. Radiated power experiments were performed on Al, Ge, Gd, Si, Ni, Fe, Pt, Pd, V, Mo, Ta, and W using an electron-bombardment zone-refining furnace operated with space-charge limited current. The experiments agreed well with the prediction $P = 4\pi(e_0 k/5)^{1/2} R^{3/2} T^{5/2}$ for a very thin bar with an infinitesimal zone length.

10614 THERMAL CONDUCTIVITY AS A NON-DESTRUCTIVE TESTING TECHNIQUE. R.W.Powell.
Progress in non-destructive testing. Vol. 1 (see Abstr. 9238 of 1961) p. 199-226.
Thermal conductivity is a relative newcomer as a non-destructive testing technique. In this review article, earlier thermal conductivity methods are first considered. For rapid determinations instruments of the comparator type are required. The thermoelectric comparator, the simple non-destructive thickness gauge, and the thermal comparator and its uses for sorting materials and its potentialities for measuring surface finish and the thickness of foils and surface deposits are discussed. The article concludes with some general notes and data on thermal conductivity. There are 66 references. J.B.Birk

10615 PROPOSED METHOD OF MEASURING THERMAL DIFFUSIVITY AT HIGH TEMPERATURES. R.D.Cowan
J. appl. Phys. (USA), Vol. 32, No. 7, 1363-70 (July, 1961).
A method is proposed for determining the thermal diffusivity of a thin solid plate, mounted in a vacuum and heated to incandescence by means of a high-energy electron beam impinging on one face of the plate, or heated by thermal radiation from an arc-imaging furnace. The beam energy is to be modulated by either a square wave or sine wave, and the resulting temperature modulation of the faces is to be observed photoelectrically. A theoretical study is made of the possibility of deducing the thermal diffusivity of the solid from amplitude and/or phase measurements. The most practical method seems to be that which involves sine wave modulation, and measurement of the phase difference between the temperatures of the two faces of the plate. With a plate thickness of about 1 mm and frequencies of the order of 0.01-300 c/s (depending on the value of α), it should be possible to measure thermal diffusivities, especially of the poorer conductors (α less than about 0.1 cm^2/sec), for temperatures from 1000°K or less to the point where sublimation becomes troublesome.

10616 HEAT TRANSFER DURING THE FLOW OF A LIQUID METAL IN THE LAMINAR AND TRANSITION REGIONS.
S.Petukhov and A.Ya. Yushin.
Dokl. Akad. Nauk SSSR, Vol. 136, No. 6, 1321-4 (Feb. 21, 1961). In Russian.
For abstract, see Abstr. 8250 of 1961. [English translation in: Soviet Physics—Doklady (USA), Vol. 6, No. 2, 159-61 (Aug., 1961)].

10617 THERMAL EXCHANGE FOR NON-NEWTONIAN FLUIDS IN LAMINAR MOTION IN CIRCULAR TUBES. . THERMAL EXCHANGE FOR VARIABLE WALL TEMPERATURE.
L.Dente.
C Accad. Naz. Lincei (Italy), Vol. 29, No. 5, 336-44 (Nov., 1960). In Italian.
For Pt I see Abstr. 5255-6 of 1961. The mathematical discussion is extended by use of the Laplace transform to the case where the wall temperature varies linearly with distance along the tube. S.Weintroub

10618 KAPITZA [THERMAL] RESISTANCE BETWEEN HELIUM AND METALS IN THE NORMAL AND SUPERCONDUCTING STATES. W.A.Little.
Phys. Rev. (USA), Vol. 123, No. 2, 435-41 (July 15, 1961).
In 1941 Kapitza (Abstr. 3003 of 1941) observed that when a solid was heated while immersed in liquid helium a discontinuous jump occurred in the temperature crossing the solid-liquid interface. The thermal resistance which gives rise to this discontinuity has become known as the Kapitza resistance and is the subject of the present paper. The contribution of the conduction electrons of a metal to the heat flow across a helium—metal interface is calculated. It is found that the "totally" reflected phonons from the fluid play an important role in the transfer mechanism as had been predicted previously. The dominant term in the heat flow is proportional to $T^3\Delta T$, in agreement with the experimentally observed value on lead. However, the numerical agreement is poor. The reasons for this are discussed. In the superconducting state it is shown why this heat transfer becomes inoperative. Several interesting consequences of this calculation are given. In particular, it is predicted that a phonon-drag effect may be observed between the conduction electrons in the metal and the phonons in the fluid and vice versa. Also, it is shown that the variation of the Kapitza resistance with applied magnetic field can help to distinguish between the various contributions to the heat flow.

10619 ON A CONTACT HEAT CONVECTION PROBLEM.
L.I.Rubinshtein.
Dokl. Akad. Nauk SSSR, Vol. 135, No. 4, 805-8 (Dec. 1, 1960). In Russian.
For abstract, see Abstr. 4495 of 1961. [English translation in: Soviet Physics—Doklady (USA), Vol. 5, No. 6, 1202-5 (May-June, 1961)].

CONVECTIVE CIRCULATION IN WATER INDUCED BY EVAPORATIVE COOLING. See Abstr. 10481

10620 THE DISTANCE CORRELATION BETWEEN PHOTONS IN BLACK BODY RADIATION. F.A.Kaempffer.
Canad. J. Phys., Vol. 39, No. 3, 473-5 (March, 1961).
The theory of the perfect Bose gas is applied to the calculation of the density of photons at a distance and from any given photon. The correlation distance is found to be comparable with the wavelength of maximum intensity, and it is suggested that the conclusion may be experimentally verifiable, since the wavelength of visible light is large compared with atomic dimensions.
H.N.V.Temperley

10621 THE BUBBLE MECHANISM OF SHOCK-TRIGGERED COMBUSTION IN LIQUIDS. R.I.Soloukhin.
Dokl. Akad. Nauk SSSR, Vol. 136, No. 2, 311-12 (Jan. 11, 1961). In Russian.
For abstract, see Abstr. 4500 of 1961. [English translation in: Soviet Physics—Doklady (USA), Vol. 6, No. 1, 16-17 (July, 1961)].

10622 BURNING RATE MEASUREMENT OF SOLID PROPELLANTS. L.Spenadel.
Rev. sci. Instrum. (USA), Vol. 32, No. 7, 837-9 (July, 1961).
An improved technique for measuring the burning rate of experimental propellants is described. By using a thick $\frac{1}{4}$ in. i.d. Lucite cylinder to hold the propellant grain, none of the usual inhibition problems are encountered. In addition, since the Lucite does not char on burning, the technique is ideally suited for high-speed window bomb photography. Although this technique was developed for the measurement of the burning rate of solid propellants, also liquids, pastes, gels, hygroscopic materials — can all be handled with equal facility.

10623 TEMPERATURES UNDER STEADILY HEATED FLOORS.
I.G.Donaldson.
Brit. J. appl. Phys., Vol. 12, No. 6, 300-6 (June. 1961).
The temperature distribution below the heated floor of a kiln has been investigated both theoretically and by model experiments. The aim is to determine how much insulation is required to keep the temperature of the ground below that point (perhaps at low as 40°C) at which it tends to dry out and subside. The results show that a considerable thickness of insulation is necessary to achieve this, but that much less insulation is needed if a thin layer of high conductivity is placed below the insulation. Iron reinforcing mesh could act as a high conductivity layer. It also appears that there is an advantage both in cost and in effectiveness in making the insulation thinner toward the sides of the kiln. The conclusions also apply to the insulation of the floor of cold storage rooms and skating rinks where the aim is to prevent "frost heave".

10624 PLATINUM THERMOMETER FOR CALORIMETRIC WORK. V.N.Kostryukov.
Pribory i Tekh. Eksper. (USSR), 1959, No. 6, 121-2 (Nov.-Dec.). In Russian.
The element of the thermometer described is a sectionalized helical Pt wire of 0.05 mm diameter assembled in a multicapillary tube quartz former consisting of a bunch of 6 to 8 thin-walled capillary tubes, 20 to 25 mm long and 0.6 to 0.7 mm internal diameter, welded together and enclosed in a thin-walled quartz jacket. The thermometer is filled with pure helium at 10 to 15 mm Hg pressure and hermetically sealed. The resistance at room temperature is approx. 100 ohm and the thermal inertia corresponds to a 7 to 9 sec delay time. [English translation in: Instrum. exper. Tech. (USA), No. 6, 978-9 (Nov.-Dec., 1959; publ. Sept., 1960)]. S.Weintroub

10625 CHARACTERISTICS OF SEVERAL CARBON THERMOMETER-HEATERS AT LOW TEMPERATURES AND IN MAGNETIC FIELDS TO 100 KILOGAUSS.
E.W.Hornung and D.N.Lyon.
Rev. sci. Instrum. (USA), Vol. 32, No. 6, 684-7 (June, 1961).
Several thermometers were prepared with various sizes of carbon particles and new rugged construction methods. The resistance of the thermometers was measured as a function of temperature from 1.217° to 20.355°K and as a function of magnetic field from 0 to 94 500 G. No simple functional relationship holds between resistance and temperature or between resistance and magnetic field. An approximately square dependence of the resistance on the magnetic field holds for some thermometers at small fields, but in no case does this dependence continue at high fields.

10626 HIGH TEMPERATURE KNUDSEN EFFUSION SAMPLING SYSTEM. M.B.Panish and L.Reif.
Rev. sci. Instrum. (USA), Vol. 32, No. 7. 831-2 (July, 1961).
A simple electron-bombardment furnace for Knudsen effusion (vapour pressure) studies is described. Temperatures as high as 2700°K have been maintained in this system at pressures of the order 10^{-6} mm Hg.

CHANGE OF STATE

(Solid-state phase transformations are included primarily under Structure of Solids)

10627 MEASUREMENT OF THE PARTIAL PRESSURE OF CESIUM OVER CESIUM ANTIMONIDES. K.Miyake.
J. appl. Phys. (USA), Vol. 32, No. 6, 1132-6 (June, 1961).
The partial pressure of Cs over Cs antimonides whose compositions were $Cs_{2.95}Sb$, $Cs_{3.00}Sb$, and $Cs_{3.25}Sb$ was measured at various temperatures from room temperature to about 180°C. The experimental tube consisted of a spherical glass envelope and an ion gauge. The sample was prepared on the inner surface of the spherical envelope. The partial pressure of the caesium dissociated thermally from caesium antimonides was measured by Langmuir's positive-ion method. The composition of the samples was determined by comparing their electrical resistivities and thermal

activation energies associated with electrical conductivity with those of caesium antimonides of known composition. The preparation of the sample and the measuring method of the partial pressure of caesium are described. The partial pressure of caesium over caesium antimonides was measured as a function of the absolute temperature, and the results showed that it was represented by the equation $\log_{10}p$ (mm Hg) = A − B/T, where A and B are constants. In the case of $Cs_{3.00}Sb$, the values of A and B were 9.040 and 6300 deg, respectively.

10628 VAPOR PRESSURES OF THE NEON ISOTOPES.
J.Bigeleisen and E.Roth.
J. chem. Phys. (USA), Vol. 35, No. 1, 68-77 (July, 1961).

The ratio of the vapour pressures of Ne^{20} and Ne^{22} was measured in the temperature range 16°-30°K. An accuracy of about 1% in the logarithm of the vapour-pressure ratio was achieved. The latter is checked by comparisons of (1) triple-point pressures; (2) equilibrium fractionation experiments, and (3) the entropy difference of the condensed phases with thermal measurements. The Debye temperature for the solid derived from the ratio of the vapour pressures, 74.6°K, is in good agreement with values derived from the Debye–Waller temperature factor and theoretical calculations by Bernardes. The discrepancy between the characteristic temperatures derived from measurements of free energy with those from heat capacities is attributed to the role of the anharmonicity of the lattice. It is shown that the difference in the thermodynamic properties of solid and liquid neon in the vicinity of the triple point can be attributed to the change in coordination number.

10629 EFFECT OF STRONG ELECTRIC FIELDS ON THE BOILING POINTS OF SOME ALCOHOLS.
P.K.Katti and M.M.Chaudhri.
Nature (GB), Vol. 190, 80 (April 1, 1961).

When a strong alternating electric field is applied to a boiling liquid and its vapour, it is found that the boiling point is reduced. The effect has been studied in the case of methyl, ethyl and isopropyl alcohol. T.C.Toye

THE THEORY OF CONDENSATION.
See Abstr. 10429

A FURNACE FOR VAPOUR PRESSURE MEASUREMENT.
See Abstr. 10626

LOW-TEMPERATURE PHYSICS

10630 NUCLEAR COOLING WITH METALLIC COPPER.
J.J.Fritz, H.J.Maria and J.G.Aston.
J. chem. Phys. (USA), Vol. 34, No. 1, 344-5 (Jan., 1961).

A brief description is given of the apparatus used for nuclear cooling by adiabatic demagnetization, and the results obtained are compared with those of Kurti, Robinson, Simon and Spohr (Abstr. 2137 of 1957). The observed relaxation times for the transfer of energy between the nuclear spin and the electronic system are in agreement with the recent work of Hobden and Kurti (Abstr. 4520 of 1961) although a discrepancy does exist in the value of the minimum obtainable temperature. P.A.Walker

10631 DEVICE FOR THE STABILIZATION OF HELIUM CRYOSTAT TEMPERATURES. C.J.Adkins.
J. sci. Instrum. (GB), Vol. 38, No. 7, 305 (July, 1961).

A simple but sensitive method of detecting small changes in the level of an oil manometer is applied to the stabilization of helium cryostat temperatures. At 3°K a stability to better than 10^{-4} deg K is easily obtained.

10632 SIMPLE ADIABATIC DEMAGNETIZATION APPARATUS. V.D.Arp and R.H.Kropschot.
Rev. sci. Instrum. (USA), Vol. 32, No. 2, 217-18 (Feb., 1961).

A simple inexpensive apparatus is described which uses a solenoid of superconducting niobium wire and dysprosium ethyl sulphate as the paramagnetic salt. Starting from 1°K and a field of 3000 G temperatures of about 0.17°K have been reached. The elimination of the magnet removes many of the restrictions of the conventional demagnetization apparatus. J.M.Baker

10633 CONTINUOUSLY OPERATING He^3 REFRIGERATOR FO PRODUCING TEMPERATURES DOWN TO $\frac{1}{4}$°K.
E.Ambler and R.B.Dove.
Rev. sci. Instrum. (USA), Vol. 32, No. 6, 737-9 (June, 1961).

In this portable refrigerator, the He^3 is recirculated in a system that operates without mechanical pumps. The throttling of the returning liquid is accomplished by means of a porous plug. Good regulation is obtained by using a system that allows the pressure across the porous plug to vary with the circulation rate. The lowest temperature reached while circulating was 0.26°K at zero "external" heat input, and 0.40°K at 2 mW.

Liquid and Solid Helium

10634 ION MOTION IN SUPERFLUID LIQUID HELIUM UNDER PRESSURE. L.Meyer and F.Reif.
Phys. Rev. (USA), Vol. 123, No. 3, 727-31 (Aug. 1, 1961).

Recent investigations of superfluidity by a study of the mobilit of ions in liquid He II were extended to the liquid under pressure. a fixed temperature the positive-ion mobility decreases appreciabl as the pressure is increased, particularly at low temperatures. A a fixed pressure the mobility increases less rapidly with decreasin temperature at higher pressures. The negative-ion mobility, smaller than that of the positive ion at zero pressure, becomes equ to that of the latter above 7 atm. In high electric fields and at high pressures, the drift velocity of the negative ions approaches a limiting value roughly equal to the Landau critical velocity for a body moving through the superfluid. The theory, which discussed t mobility in terms of ion scattering by rotons and phonons, is reviewed. It is pointed out that previously neglected effects concerned with the importance of small-angle scattering of the ion ought to be taken into account; some earlier estimates of scatterin cross sections are revised accordingly. It is then shown that this theory, making use only of the known change of the roton dispersio relation with pressure, can account quantitatively for the observed pressure dependence of the positive-ion mobilities.

10635 ON THE PROBLEM OF UNSATURATED HELIUM FILMS. A.D.Singh and R.K.Pathria.
Progr. theor. Phys. (Japan), Vol. 24, No. 2, 229-40 (Aug., 1960).

A theoretical explanation is given for the lowering of the transition temperature, and the increase of the entropy, with decre sing film thickness as met with in unsaturated helium films (Abstr. 5440 of 1953). It is shown that in the ideal gas approximation the boundary conditions obeyed by the eigenfunctions assume rather an important role. There is, however, no quantitative agreement between the experimental and the theoretical results even when the dependence of the film density on the thickness of the film is taken into account. On the other hand, if one considers the non-ideal gas approximation for the liquid and takes into account (1) the slow variation of the parameters Δ and μ with the film thickness, and (2) the contributions arising from the presence of surface tension waves on the liquid surface, the experimental data are explained in a good quantitative manner. In this case, however, the boundary conditions are found to become rather unimportant.

10636 LEVEL INDICATOR FOR PERMANENT INSTALLATION IN LIQUID HELIUM STORAGE DEWAR.
J.E.Zimmerman and R.C.Root.
Rev. sci. Instrum. (USA), Vol. 32, No. 7, 853-4 (July, 1961).

A liquid helium level indicator suitable for a variety of applica tions is described. It consists essentially of a superconducting inductance and coaxial condenser, along with a transistorized variable frequency oscillator and an r.f. voltmeter to detect the resonance. The resonant frequency is very nearly a linear function of the height of liquid helium in the coaxial condenser. The indicator probe may be mounted permanently in a narrow-necked storage or experimental Dewar, since the small-diameter lead-in wire does not interfere with the operation of transferring liquid to or from the vessel.

KAPITZA [THERMAL] RESISTANCE BETWEEN HELIUM AND METALS IN THE NORMAL AND SUPERCONDUCTING STATES.
See Abstr. 10618

Superconductivity

10637 BOUNDARY-LAYER BEHAVIOR IN THE SUPERCONDUCTOR TRANSITION PROBLEM.
H.Cohen and W.L.Miranker.
J. math. Phys. (USA), Vol. 2, No. 4, 575-83 (July-Aug., 1961).

A superconducting material may be isothermally transformed to a normal conductor by raising the magnetic field to a value greater than a certain critical field. When this is done, the transition takes place along an interface, determined by the critical field value and by a magnetic-flux condition. In the present paper, the effect on the transition rate of magnetic-field penetration into the superconductor is studied. This involves the solution of a free-boundary problem in which the free boundary divides two regions, each governed by a different parabolic differential equation. The problem is solved by using the asymptotic techniques of singular perturbation theory. A boundary layer is shown to exist along the moving interface on the superconducting side. The presence of the boundary layer slows the motion of the free boundary. Also included in the solution is a study of the effect of the magnitude of the initial field on the starting motion of the free boundary. Finally, some numerical results are presented.

10638 EXACT WAVE FUNCTIONS IN SUPERCONDUCTIVITY. D.Mattis and E.Lieb.
J. math. Phys. (USA), Vol. 2, No. 4, 602-9 (July-Aug., 1961).

The ground-state wave-function and some of the excited states of the BCS reduced Hamiltonian are found. In the limit of large volume, the boundary and continuity conditions on the exact wave-function lead directly to the equations which Bardeen, Cooper, and Schrieffer found by a variational technique. It is also shown in what sense the BCS trial wave-function may be considered asymptotically exact in this limit. Finite-volume corrections are included in an appendix, and explicit calculations are carried out for a one-step model of the kinetic energy which has possible applications to the problem of the finite nucleus.

10639 TUNNELING FROM AN INDEPENDENT-PARTICLE POINT OF VIEW. W.A.Harrison.
Phys. Rev. (USA), Vol. 123, No. 1, 85-9 (July 1, 1961).

A method is developed for calculating wave-functions through regions of varying band structure. This method is applied to tunnelling problems using the transition-probability approach of Bardeen (Abstr. 5395 of 1961). It is found that the experiments of Giaever (Abstr. 16949 of 1960) involving tunnelling into superconductors cannot be understood strictly in terms of an independent-quasi-particle model of the superconductor. The observed proportionality of the tunnelling probability to the density of states depends upon the matrix elements being constant which, in turn, depends upon a many-particle feature of the problem. This feature does not carry over to fluctuations in the density of states arising from band structure, and contributions to the current are not expected to be proportional to the density of states in that case. Instead, a projection in wave-number space of the appropriate constant-energy surface enters. Tunnelling systems are discussed which involve semiconductors, semimetals, and transition metals as well as simple metals. Finally, alterations in the properties arising from alterations in the nature of the boundary regions are discussed.

10640 DIFFERENTIAL PARAMAGNETIC EFFECT IN SUPERCONDUCTORS. R.A.Hein and R.L.Falge, Jr.
Phys. Rev. (USA), Vol. 123, No. 2, 407-15 (July 15, 1961).

The magnetic moment and the differential magnetic susceptibility of two spherical samples of tin and tantalum were measured as a function of magnetic field and temperature. The differential paramagnetic effect (DPE) is observed in both a.c. and d.c. mutual inductance measurements provided the sample exhibits a good Meissner effect. For a superconducting sample in which the infinite conductivity behaviour dominates the Meissner effect, the DPE does not appear in the a.c. measurements but does, under certain conditions, show up in d.c. measurements. The results of the d.c. mutual inductance measurements are used to classify the DPE as reproducible or non-reproducible. The former is characteristic of ideal Meissner-type superconductors while the latter is more characteristic of superconductors whole macroscopic magnetic properties are dominated by the classical infinite electrical conductivity behaviour. The superconducting to normal transitions obtained by the three techniques are compared and the data discussed in view of (a) occurrence of the DPE; (b) magnitude of the DPE; (c) ability of these data to give information about the volume participation of the sample; and (d) relation of the "characteristic magnetic fields" determined by these transitions and the bulk critical field of the sample.

10641 SIZE EFFECTS IN THIN SUPERCONDUCTING INDIUM FILMS. A.M.Toxen.
Phys. Rev. (USA), Vol. 123, No. 2, 442-6 (July 15, 1961).

Measurements of residual resistivity, superconductive critical temperature, and critical magnetic field were carried out on indium films ranging in thickness from 650 to 126 000 A. The thickest films had the bulk critical field and critical temperature. The variation of residual resistivity with thickness is consistent with Fuchs' model if one assumes an intrinsic resistivity ρ_0 of 1.31×10^{-5} ohm cm and an intrinsic mean free path l_0 of 152 000 A. The value of $\rho_0 l_0$ so obtained was 2.0×10^{-11} ohm cm^2. The critical temperature was found to be a systematic function of film thickness, increasing with decreasing thickness. The magnitude of this change in critical temperature is in good agreement with a simple model relating critical temperature to elastic stresses in the films. The penetration depth, as calculated from the critical field by means of the London theory or the Ginzburg—Landau theory, was found to increase with decreasing film thickness. This result is consistent with a non-local model and implies a coherence length of approximately 2600 A.

10642 STUDY OF THE SUPERCONDUCTING TRANSITION TEMPERATURE IN DILUTE THALLIUM SOLID SOLUTIONS. D.J.Quinn and J.I.Budnick.
Phys. Rev. (USA), Vol. 123, No. 2, 466-9 (July 15, 1961).

The superconducting transition temperature, T_c, was measured for dilute solid solutions of indium, bismuth, and lead in thallium. The transition temperature is found to increase in all cases thus exhibiting a behaviour opposite to that observed by Serin, Lynton, and co-workers [J. Phys. Chem. Solids (GB), Vol. 3, 165 (1957); Abstr. 9658 of 1959] in their studies of solid solutions of tin, indium, and aluminium. Some loss in residual impurity scattering which occurs upon annealing suggests the migration of solute atoms to grain boundaries in the dilute alloys.

10643 COLLECTIVE MODES IN THE THEORY OF SUPERCONDUCTIVITY. D.J.Thouless and D.R.Tilley.
Proc. Phys. Soc. (GB), Vol. 77, Pt 6, 1175-81 (June, 1961).

Some results which were derived by use of finite temperature perturbation theory are used to investigate the possibility of a low-energy collective mode in a superconductor. It is found that such a mode should exist, and the ratio of its energy to its momentum is calculated. This ratio approaches infinity exponentially as the temperature goes to zero, in agreement with Anderson's result that at zero temperature the collective mode is destroyed by the Coulomb force. The effect of this collective mode on the specific heat is negligible. The relation of this mode to "second sound" is discussed. A comparison is made between the behaviour of this collective mode in a charged superfluid system (superconductor) and the behaviour of the collective modes in a superfluid system of neutral fermions.

10644 THE MEISSNER EFFECT IN THE QUASI-CHEMICAL EQUILIBRIUM THEORY OF SUPERCONDUCTIVITY. J.M.Blatt.
Progr. theor. Phys. (Japan), Vol. 24, No. 4, 851-76 (Oct., 1960).

Gives an explicitly gauge-invariant proof of the Meissner—Ochsenfeld effect (magnetic field expulsion from a superconductor), using the quasi-chemical equilibrium theory of superconductivity. The essential condition for a Meissner effect is the Bose—Einstein condensation of electron pairs. Other aspects of the problem, such as the energy gap and plasma waves, are not necessary for the Meissner effect and do not appear in the calculation. No use is made of the random phase approximation.

10645 ANOMALOUS LATTICE SPECIFIC HEAT OF SUPERCONDUCTORS. R.A.Ferrell.
Phys. Rev. Letters (USA), Vol. 6, No. 10, 541-4 (May 15, 1961).

The explanation of the anomaly suggested by Daunt and Olsen (Abstr. 6998 of 1961), is criticized, and an explanation is presented which is based on a shift in the lattice frequency spectrum due to the changed phonon self-energy. R.G.Chambers

10646 EFFECTIVE DENSITY OF STATES IN THE TUNNEL EFFECT. W.Franz.
Z. Naturforsch. (Germany), Vol. 16a, No. 4, 436-8 (April, 1961). In German.

Experiments on the tunnel current between a) a normal and a superconducting metal or b) between two superconductors are generally interpreted assuming that the characteristic curve is a picture of the density of states. The probability of the tunnel transition is here calculated in the effective mass approximation and it is found that, within certain limits, in case a) the differential characteristic and in case b) the characteristic itself give a picture of an "effective density of states" g_e related to the true density of states g by $g_e = g(1 + a^2g^2)^{-1}$, where a = v/V, V being the Fermi velocity and v = dE/dk, where k is the imaginary momentum in the barrier. L.Pincherle

ELECTRICITY
ELECTRICAL MEASUREMENTS AND CIRCUITS

10647 CONCERNING THE NAMING OF THE "PRACTICAL" ELECTRICAL UNITS. E.S.Barr.
Amer. J. Phys., Vol. 29, No. 8, 532-9 (Aug., 1961).

One hundred years ago the first steps toward the establishment and naming of the units of the familiar "practical" electrical units system were taken. The present paper is concerned with tracing the devious development of the complete system, with special emphasis on the circumstances attendant to the assigning of the unit names.

10648 SMALL SIGNAL IMPEDANCE OF A SOLID CORE INDUCTANCE. F.Kollar and R.D.Russell.
Brit. J. appl. Phys., Vol. 12, No. 6, 307-10 (June, 1961).

The design of a highly stabilized control system for a large electromagnet requires the knowledge of its small signal impedance as a function of frequency. The impedance of such an electromagnet was calculated, taking into account the effects of eddy currents but ignoring non-linearities in the magnetizing curve of the iron. It has been possible to use typical values for the relative incremental permeability and conductivity of iron to obtain a rather good estimate of its impedance over four decades above the lowest frequency for which reactive components of the impedance are significant. There is a change in slope in the curve of the magnitude of the impedance at a frequency corresponding to a skin depth equal to approximately three-quarters of the radius of cross-section of the core. Above this frequency the magnitude of impedance rises at 3 dB per octave and the phase angle approaches 45°. At much higher frequencies the existence of stray capacities causes deviations from this predicted behaviour.

10649 AMMETERS DEPENDING ON THE REPULSION BETWEEN PARALLEL ELECTRIC CURRENTS. L.Rebuffé.
J. Phys. Radium (France), Vol. 21, No. 1, 77-9 (Jan., 1960). In French.

Electric current meters (for a.c. or d.c.) are described, based on the international definition of the ampere. C.A.Hogarth

10650 SIMPLE A.C. RESISTANCE BRIDGE USING A D.C. BREAKER AMPLIFIER. B.A.Green, Jr.
Rev. sci. Instrum (USA), Vol. 32, No. 3, 364 (March, 1961).

The bridge has 150Ω ratio arms, a six-decade (100Ω in 0.1kΩ steps) variable arm, and is for use with a 47Ω carbon resistor thermometer for measuring liquid He temperatures. The bridge supply is derived from two mercury cells (2 × 1.34 V) and the 8 c/s chopper of a Liston–Becker d.c. amplifier, the remainder of which serves as a narrow band (~ 1 c/s) amplifier and phase-sensitive detector. The thermometer resistance is 500Ω at 4°K and 5000Ω at 1.7°K. The minimum detectable change is 0.1 Ω in 10 kΩ. C.F.Pizzey

10651 AN A.C. SILICON RESISTIVITY METER. C.C.Allen and W.R.Runyan.
Rev. sci. Instrum. (USA), Vol. 32, No. 7, 824-8 (July, 1961).

A versatile, all transistor silicon four-point probe resistivity meter incorporating a d.c. probe bias supply in conjunction with an a.c. measuring circuit is described. It is direct reading and covers a resistivity range of from 0.01 ohm cm full scale to 300 ohm cm full scale. With minor changes the range can be increased to 1000 ohm cm.

10652 APPARATUS DRAWINGS PROJECT. REPORT NUMBER 20. VERSATILE ELECTRIC STOP CLOCK CONTROL SYSTEM. R.G.Marcley.
Amer. J. Phys., Vol. 29, No. 8, 498-503 (Aug., 1961).

A flexible system for controlling a 10 in. diameter 0.01 sec electric stop clock by means of a photoconductive cell and/or electric contacts is described. A moving element of the lecture demonstration to be timed is utilized to operate the photocell and the nonperturbing electrical contacts in various combinations. Under optimum conditions, the absolute accuracy of the system is better than ±0.05 sec with a reproducibility of about ±0.01 sec. Manual control of the clock is retained. The components used are conventional and low in cost.

10653 FIXED ATTENUATORS CONSISTING OF A NETWORK OF IDENTICAL RESISTORS. C.H.Vincent.
J. sci. Instrum. (GB), Vol. 38, No. 7, 288-90 (July, 1961).

These attenuators have advantages of freedom from distortion by the stray self-inductance of the resistors and freedom from the effects of ambient temperature changes. A suitable form for such attenuating networks is described. It is possible to design a network of this form to give attentuation in any ratio N to 1, where N is an integer. The minimum number of resistors needed for any value of N is not excessive, being less than seven resistors per decade of N. A table is given which makes the calculation of an optimum network very easy for any value of N up to 400.

10654 EXACT CALCULATION OF THE FLUCTUATION SPECTRUM FOR A NONLINEAR MODEL SYSTEM. N.G.van Kampen.
J. math. Phys. (USA), Vol. 2, No. 4, 592-601 (July-Aug., 1961).

Fluctuations in a circuit consisting of a diode and a condenser have been treated by means of approximate methods (Abstr. 8564 of 1960; 7094 of 1961). In the present paper, exact eigenfunctions and eigenvalues of the master equation for this system are obtained and the spectral density of the equilibrium fluctuations is calculated. The most striking result is that the spectrum of the eigenvalues (which are reciprocal relaxation times) has an accumulation point, corresponding to the average time interval between two successive electron transitions.

10655 PROPERTIES OF 2-SEMI-ISOMORPHIC GRAPHS AND THEIR APPLICATIONS: ACTIVE NETWORK ANALYSIS. I.T.Frisch and W.H.Kim.
J. math. Phys. (USA), Vol. 2, No. 4, 627-35 (July-Aug., 1961).

Two-semi-isomorphic graphs are defined by extending Whitney's concept of bi-isomorphic graphs. The properties of these newly defined graphs are then investigated. The discussion leads to the derivation of a simple formula for the determination of the sign of a tree product which is common to two bi-semi-isomorphic graphs. The formula is then applied to the topological analysis of mutually coupled active networks.

10656 LOW TEMPERATURE ELECTROMETER CIRCUIT. J.A.Carruthers, D.E.Benyon and J.Nicholls.
Nucleonics (USA), Vol. 18, No. 12, 84, 86 (Dec., 1960).

The circuit described reduces the voltage dependence of a floating-grid electrometer tube circuit. It is applicable to battery-operated ion-chamber survey meters which may have to operate at low temperature. R.D.Smit

10657 AMPLIFIER FOR THE GENERATION OF ACCURATELY CONTROLLED MICROSECOND PULSES. J.B.Gunn.
Rev. sci. Instrum. (USA), Vol. 32, No. 7, 804-7 (July, 1961).

A description is given of a pulse amplifier whose output voltage can be accurately controlled by the setting of a ten-turn potentiometer. The output amplitude and pulse lengths are variable up to 1000 V, 2.6 A, and 10 μsec, respectively. An accuracy of 2 V is achieved, independently of external conditions, by the use of strong negative feedback to compare the output with a reference d.c. voltage. The various sources of error are discussed.

LOW IMPEDANCE BRIDGE FOR THE MEASUREMENT OF LEVEL OF LIQUID METALS. See Abstr. 10473

ELECTROSTATICS . DIELECTRICS

(The study of solids through their dielectric properties is included under Solid-State Physics; similarly for Liquid State and Gaseous State)

10658 A CONTRIBUTION TO THE THEORY OF THE DISPLACEMENT OF THE EQUI-POTENTIAL LINES IN)LAR DIELECTRICS SUBJECTED TO AN INHOMOGENEOUS LECTRIC FIELD. G.H.Krawinkel.
angew. Phys. (Germany), Vol. 13, No. 4, 202-11 (April, 1961). German.

It has been shown that the potential distribution in a polar electric subjected to an inhomogeneous cylindrical field is quite fferent from that in a non-polar dielectric in the same field. A n-linear relationship also exists between the conduction current d the intensity of the applied field. These effects are explained eoretically in terms of space-charges in the vicinity of the undaries between the electrodes and the dielectric.

V.G.Welsby

10659 CHARGED CYLINDRICAL TUBE.
T.R.Ferguson and R.H.Duncan.
. appl. Phys. (USA), Vol. 32, No. 7, 1385-7 (July, 1961).

The Fourier series for the charge density on a hollow tube of nite length is found in such a way that the Fourier coefficients are ne unknowns of a system of linear equations. A machine method s used to solve the set of equations in finite order. The leading oefficient is the most accurately known at any order, and solely etermines the capacitance of the tube. Capacitances are determined for various ratios of half-length to radius to an accuracy f better than 0.02%. The technique of solving the integral equation or charge density is useful in other physical problems.

CURRENT ELECTRICITY ELECTROKINETICS

(The study of solids through their electrical conduction properties is included under Solid-State Physics)

10660 CONSERVATIVE FIELDS IN D.C. NETWORKS.
E.M.Pugh.
Amer. J. Phys., Vol. 29, No. 8, 484-6 (Aug., 1961).

The desirability of writing $\oint \mathbf{E} \cdot d\mathbf{l} \neq 0$ in d.c. networks is questioned. Since a general relation of Maxwell is $\nabla \times \mathbf{E} = -dB/dt$, $\nabla \times \mathbf{E} = 0$, and $\oint \mathbf{E} \cdot d\mathbf{l} = 0$ wherever $dB/dt = 0$. However, within "sources of e.m.f." charges are transported against this E field. The "forces" responsible for transporting charges against the E field should not be ascribed to an electric field since they depend upon the physical properties of the charged particles.

10661 FLUCTUATIONS AND THE ELECTRICAL CONDUCTIVITY OF METALS. T.Lukes.
Physica (Netherlands), Vol. 27, No. 3, 319-28 (March, 1961).

A proof is given on the basis of equilibrium fluctuation theory, of the Kubo expression for electrical conductivity (Abstr. 8437 of 1957). The expression is evaluated explicitly for the case of isotropic scattering (Sommerfeld model) and for non-isotropic scattering at high temperatures. For both cases the results agree with those derived by using the Boltzmann equation; for the case of non-isotropic scattering the results are valid provided the conditions $\hbar/\tau \ll E_F$, $T \gg \theta_D$, are satisfied.

10662 ELECTRICAL CONDUCTION IN A STRETCHED AND TWISTED TUBE. A.C.Pipkin and R.S.Rivlin.
J. math. Phys. (USA), Vol. 2, No. 4, 636-8 (July-Aug., 1961).

The constitutive equation derived in a previous paper (Abstr. 16964 of 1960) relating electric current and field in an isotropic material which is subjected to a time-independent deformation is applied to the solution of the problem of electrical conduction in a twisted tube of circular cross-section to which a longitudinal electric field is applied. It is shown that the current follows a helical path and that an axial magnetic field is produced.

RESISTANCE OF A SOLID CONDUCTING CYLINDER DUE TO THE PRESENCE OF A CONCENTRIC SPHERICAL CAVITY. See Abstr. 10485

10663 AMPLITUDE-DISTRIBUTION ANALYZER.
E.L.Pipkin.
Rev. sci. Instrum. (USA), Vol. 32, No. 6, 670-3 (June, 1961).

Instrumentation to record automatically amplitude distribution curves is described. Basically the method employed is that proposed by Landon in which the relative lengths of time that a signal is equal to, or less than, a given amplitude are measured. A digital approach, similar to that of Davenport, is made. However, instead of modulating a pulse train with the studied signal, as done by Davenport, the described analyser mixes the amplitude of a high frequency sinusoid with the studied signal, producing greater stability and requiring less bandwidth. The amplitude is scanned by reducing the amplitude of the carrier sinusoid, while keeping the r.m.s. value of the studied signal constant. The distribution curves of a random noise sample and of two sinusoids, the latter of which are used in calibration of the amplitude axis, are presented.

10664 HIGH VOLTAGE SQUARE-WAVE GENERATOR.
H.W. de Wijn.
Rev. sci. Instrum. (USA), Vol. 32, No. 6, 735-6 (June, 1961).

Describes a generator intended for the modulation of the electric field in the absorption cell in a microwave Stark-spectrograph. Peak-to-peak voltages of up to 1900 V were produced, feeding into a 1200 $\mu\mu$f capacitive load. The frequency may be chosen at any value between 10 and 120 kc/s. Rise and fall times of the square wave are less than 0.2 μsec.

VACUUM SEALING OF GOLD WIRE LEADS TO A DIFFERENTIAL THERMOPILE. See Abstr. 10556

IONIZATION

10665 DYNAMICS OF IONIZED GASES.
T.H.Dupree.
Phys. of Fluids (USA), Vol. 4, No. 6, 696-702 (June, 1961).

Ionized gas dynamics is discussed in terms of two coupled equations for the one- and two-particle distribution functions. The equations have been obtained previously by multiple integration of the Liouville equation and a formal expansion in the specific volume. The two-particle equation is solved for a multicomponent plasma in terms of two operators which depend on the one-particle functions. It is shown that these operators have a simple interpretation and lend an easy insight into the correlation mechanism. If one neglects the time dependence of the one-particle functions which occur in the operators, then the operators can be obtained explicitly. This procedure is shown to be valid for plasmas with "smooth" velocity distributions and no large inhomogeneities. When velocity instabilities exist, the correlation function is subject to growing oscillation. The ultimate effect of this instability is not clear.

10666 GENERALIZATIONS OF THE SAHA EQUATION.
E.M.Dewan.
Phys. of Fluids (USA), Vol. 4, No. 6, 759-64 (June, 1961).

The Saha equation (1920), which relates temperature to ion densities, is sometimes used under circumstances that do not justify the assumptions of thermodynamic equilibrium upon which it is based. Astronomers have therefore made generalizations of this equation but have unfortunately assumed thermodynamic equilibrium energy distributions for the particles and the radiation field even though these may be at different temperatures. It is therefore interesting to know how the nonequilibrium steady-state energy distributions affect the ionization densities. In the present treatment a general expression relating ion densities to the radiation and particle energy distributions is obtained. This equation reduces to Saha's equation in the limit of thermal equilibrium and gives numerical results in good agreement with other work based on entirely different considerations, thus providing a good check. It is found that under certain conditions one would expect results that differ enormously from those predicted by the Saha equation.

10667 DISSOCIATION OF ADSORBED CO BY SLOW ELECTRONS. G.E.Moore.
J. appl. Phys. (USA), Vol. 32, No. 7, 1241-51 (July, 1961).

Investigations were made on ions emitted from Mo and W surfaces in CO when the surfaces were bombarded by electrons. The surfaces, in the form of ribbons, could be cleaned at will be

heating, and bombarded by an electron stream in which current and energy were controlled separately. The product ions were observed in a mass spectrometer whose envelope contained the experimental filament. Electron bombardment liberated only the O^+ ion from adsorbed CO with any abundance; it may be 50-100 times more abundant from the surface than from space. No CO^+ nor C^+ ions were detected nor any negative ions of CO or its fragments. Carbon atoms remained on the surface. Significant amounts of F^+ and Cl^+ were also liberated from new filaments; these diffused from the interior and were more tightly bound than CO, and disappeared only after prolonged heating. Their surface abundance was so slight that they did not interfere with the O^+ process. The threshold electron energy for liberation of O^+ ions and the dependence of O^+ ion current on electron current and energy are given. The method might be useful for studying kinetics of complex adsorption phenomena, although precautions are necessary to avoid perturbing the adsorbed film by the incoming electrons. The following phenomena can be readily observed and probably understood: (a) The growth of a monomolecular film of CO from the ambient following a flash of the filament. (b) Competition for available sites by chlorine, fluorine, carbon, and CO. (c) Poisoning of the surface, for adsorption of CO, by carbon atoms freed by departure of O^+ ions. A simple theory reproduces the experimental kinetics of adsorption and poisoning semiquantitatively.

10668 POSITIVE AND NEGATIVE ION FORMATION IN CCl_3F. R.K.Curran.
J. chem. Phys. (USA), Vol. 34, No. 6, 2007-10 (June, 1961).

A mass spectrometer with an ion source utilizing nearly monoenergetic electrons was used to measure appearance potentials of positive and negative ions in CCl_3F. Kinetic energy measurements were made on the negative ions. The results give values for the ionization potentials of CCl_3, CCl_2F, and CClF. The C—F and C—Cl bond energies were determined from measurements on the negative fluorine and chlorine ions. A value is given for the electron affinity of the CCl_3 radical.

10669 EFFECT OF ELECTRON ENERGY ON SOME ELECTRON-IMPACT PROCESSES. S.Meyerson.
J. chem. Phys. (USA), Vol. 34, No. 6, 2046-9 (June, 1961).

Decomposition processes induced by electron impact have been inferred from appearance potentials and from isotopic distributions of fragment ions in mass spectra of labelled compounds. Implicit in such inferences is an assumption that the paths by which the fragment ions are formed are the same near the appropriate appearance potentials as at the higher electron energies usually employed. For five ions that were the subjects of earlier studies — $C_7H_7^+$ from two deuterated p-xylenes and $C_5H_5^+$ from two deuterated toluenes and a deuterated benzyl chloride — isotopic distribution was found to be essentially independent of electron energy. These results support the assumption made in earlier studies.

10670 EXPERIMENTAL TOWNSEND IONIZATION COEFFICIENTS FOR ISOPENTANE. A.E.D.Heylen.
J. chem. Phys. (USA), Vol. 35, No. 1, 169-74 (July, 1961).

Townsend α and γ values were measured over the range $60 \leq E/p_0 \leq 3000$ for isopentane using the d.c. method of measuring the ionization current. The experimental apparatus and procedure are described. It is shown that Townsend's law $\alpha/p_0 = A \exp(-Bp_0/E)$ is obeyed within $80 \leq E/p_0 \leq 500$. Positive ion action at the cathode sets in at $E/p_0 \geq 500$. The results agree with previous breakdown measurements. It was found possible to follow the current growth due to ionization of the gas over a multiplication range exceeding eight orders of magnitude. The influence of space-charge distortion within single avalanches and that due to neighbouring ones was examined. No space-charge reduction of the avalanche multiplication was observed until $e^{\alpha d} \geq 10^7$.

10671 SPECTROSCOPIC STUDIES OF IONIZATION IN A HOLLOW-CATHODE DISCHARGE. K.B.Mitchell.
J. Opt. Soc. Amer., Vol. 51, No. 8, 846-53 (Aug., 1961).

The influence of carrier gas, carrier gas pressure, cathode geometry, and discharge current on the ionization of metal atoms in a hollow-cathode discharge was studied in some detail. Most of these studies were made with an iron hollow-cathode discharge. A measure of ionization was obtained from the intensity ratio of a line of the second to a line of the first spectrum. In general, this ratio was found to increase with carrier gas pressure and discharge current. This ratio also increased with increasing cathode bore diameter but decreased with increasing bore length. This ratio for iron was greatly affected by the use of different inert carrier gases. Of the five common inert gases used, xenon produced the largest value for this ratio and argon produced the smallest. The results of these studies indicated this may be a new method for distinguishing between lines emitted by the neutral atom and lines of the singly ionized atom.

POTENTIAL CURVES FOR DOUBLY POSITIVE DIATOMIC IONS. See Abstr. 9946

10672 MOBILITY OF IONS IN A SYSTEM OF INTERACTING BOSE PARTICLES. R.Abe and K.Aizu.
Phys. Rev. (USA), Vol. 123, No. 1, 10-18 (July 1, 1961).

The transport property of an ion in a dilute Bose—Einstein gas subject to an external electric field is investigated by means of the Boltzmann equation. The interaction Hamiltonian which describes the ion—phonon scattering processes is obtained by the use of the Bogolyubov transformation and the cross-section for the scattering of the ion by phonons is calculated. The solution of the Boltzmann equation is obtained by applying a variation principle and the temperature dependence of the ion mobility is shown to be T^{-4} at very low temperatures. A comparison of the results with the experimental data in liquid helium and the Khalatnikov and Zharkov theory (Abstr. 2279 of 1958) is given and also the ion mobility in a Fermi system is briefly discussed.

10673 TEMPERATURE VARIATION OF IONIC MOBILITIES IN HYDROGEN. L.M.Chanin.
Phys. Rev. (USA), Vol. 123, No. 2, 526-9 (July 15, 1961).

Measurements were made of the temperature variation of the mobilities of positive ions in hydrogen over the range 77°-300°K. The zero-field mobility values are $\mu_0 = 12.3$ cm^2 V^{-1} sec^{-1} (300°K), 13.3 (195°K), and 13.0 (77°K). The present results at 300°K are in agreement with the data of Lauer, Bradbury and Mitchell at low E/p_0, and at high E/p_0 agree with Rose's measurements. Only a single ion species was observed in the present studies. Reasons are given which support the belief that the ion observed in these measurements was H_3^+.

10674 TRANSPORT PHENOMENA IN A FULLY IONIZED GAS CONFINED IN A STRONG MAGNETIC FIELD. T.Koga
Phys. of Fluids (USA), Vol. 4, No. 7, 834-41 (July, 1961).

The distributions of ions and of electrons in the presence of a strong magnetic field in the z direction are not assumed as being almost Maxwellian. Instead, $f^0(cx^2 + cy^2, cz, x \pm r\,cy/c)$ is taken for the distributions in the zeroth approximation with respect to the ratio (Larmor radius r)/(free path length λ), and an iteration method is developed for solving the Boltzmann equation. First, defining the density of guiding centres of particles, f^0 is expanded into powers of $(r\partial f^0/\partial x)/f^0$. By coarse-graining the Boltzmann equation over one cycle of Larmor's gyration, equations of moments in the first approximation with respect to r/λ are derived. The simple mode of collision proposed by Bhatnagar et al. (Abstr. 6360 of 1954) is assumed. A special case is studied in detail in order to compare the present theory with those of other authors who assume distributions to be almost Maxwellian. The agreement is good. The effects of drifts of guiding centres caused by the spatial non-uniformity of a magnetic field and/or by a static electric field in the presence of a uniform magnetic field are investigated.

10675 CHARGE EXCHANGE, IONIZATION AND ELECTRON LOSS CROSS-SECTIONS OF Li IONS AND ATOMS OF 5 TO 22.5 keV IN H_2 AND He. J.Van Eck and J.Kistemaker.
Physica (Netherlands), Vol. 26, No. 8, 629-30 (Aug., 1960).

Experimental curves are given of the cross-sections as a function of energy, obtained using a mono-energetic beam of Li^+ ions of about 0.2 μA mm^{-2} and containing 1 to 2% of neutral atoms. J.Dutton

10676 SOLID STATE IONIZATION POTENTIALS OF SOME AROMATIC ORGANIC COMPOUNDS.
D.R.Kearns and M.Calvin.
J. chem. Phys. (USA), Vol. 34, No. 6, 2026-30 (June, 1961).

The ionization potentials of a number of solid compounds were determined by photoelectric threshold measurements. These are compared with literature values of the gaseous ionization potentials and the solid-state surface values seem to be approximately 1½ V smaller. The relation between the ionization potential of a molecule within a crystalline lattice and that in the surface of the lattice is described, and the significance of the bulk ionization for conductivity of organic lattices is discussed.

ELECTRIC DISCHARGES

10677 ELECTRON BUNCHING IN THE MULTIPACTING MECHANISM OF HIGH-FREQUENCY DISCHARGE.
J.Hatch.
appl. Phys. (USA), Vol. 32, No. 6, 1086-92 (June, 1961).

Electron bunching in the multipacting mechanism of low-pressure gh-frequency discharge, also known as the secondary electron sonance mechanism, is analysed by an extension of simple multi- acting theory. The bunching range is assumed to be that range in ie electrical phase angle ϕ within which secondary electrons mitted from one electrode can successfully traverse the interelec- ode gap in $\frac{1}{2}$ cycle and arrive at the opposite electrode with energy qual to or greater than the emission energy. At the lower voltage mit of multipacting, the $\frac{1}{2}$-cycle bunching range is shown to be $90^\circ \leq \phi \leq +90^\circ$; at the upper voltage limit, the range is narrowed $-90^\circ \leq \phi \leq -40^\circ$. Typical examples of multipacting bunching, ncluding higher-order modes, are illustrated with graphical tra- ectories. The effect of secondary emission characteristics on unching are also discussed.

10678 STREAMER MECHANISM AND MAIN STROKE IN THE FILAMENTARY SPARK BREAKDOWN IN AIR AS REVEALED BY PHOTOMULTIPLIERS AND FAST OSCILLOSCOPIC TECHNIQUES. G.G.Hudson and L.B.Loeb.
Phys. Rev. (USA), Vol. 123, No. 1, 29-43 (July 1, 1961).

A study was made of the development of the luminosity in the ransition from a corona or a Townsend prediscbarge to a filamentary spark in atmospheric air for a wide range of gap geometry extending rom a positive needle point-to-plane gap to large sphere-to-plane gaps very close to the parallel plate case. Two photomultipliers viewed thin slices of the gap perpendicular to its axis; the one fixed near the anode triggered the Tektronix 517 oscilloscope and the other, which could be moved parallel to the gap axis, provided the signal for display. From the oscillograms, cross plots of the developing spatial distribution of luminosity across the gap were obtained for a number of gaps. It was found that, in general, a primary and a secondary dendrite, and even a tertiary, in some cases, develop out from the anode to the cathode at high speeds and prepare the way for the growth of the main stroke. In divergent fields the primary dendrite consists of a number of simultaneous streamer filaments which, in all cases, cross to the cathode, while the branch streamers of the secondary dendrite slow down in mid-gap and even fail to reach the cathode in the longer gaps. There are several sets of primary–secondary dendrites before each main stroke, in longer point-to-plane gaps, with about 200 μsec between sets, and about 1μsec between the last set and the main stroke. While in the case of large sphere-to-plane gaps it was not possible to tell whether a dendrite consists of one or of several streamers, a primary (close to the cathode) and a secondary pulse can be observed in the longer gaps. With short gaps which are very close to the parallel plate case, only a secondary can be seen, and below about 1.0 to 1.3 cm a dendrite or streamer could not be resolved from the main stroke rise with the present equipment. In a few sphere-to-plane gaps, oscillograms and cross plots were obtained which show the development of the main stroke as its toe crosses from the anode to within about 0.5 cm of the cathode, at which position the luminosity distribution of the fully developed main stroke shows a trough, with a maximum near the anode and a rise toward the cathode.

10679 STREAMER MECHANISM IN FILAMENTARY SPARK BREAKDOWN IN ARGON BY FAST PHOTOMULTIPLIER TECHNIQUES. L.B.Loeb, R.G.Westberg and H.C.Huang.
Phys. Rev. (USA), Vol. 123, No. 1, 43-50 (July 1, 1961).

Using techniques developed by Hudson on air (see preceding abstract), the phenomena were studied in Linde's spectroscopically pure grade Ar gas admitted to a system using Alpert vacuum techniques, and on that gas further purified by gas cataphoresis. Study was made in a point-to-plane gap with a 2.36 mm hemispherically capped cylinder opposite a 3 cm distant thin out-gassed Ni plane in the pressure range from 300 mm to 50 mm. For the spectroscopically pure grade Ar, transition from a positive point corona through a fine filamentary spark to an incipient arc breakdown on a time scale of 10^{-7} sec down to 100 mm pressure proceeds by movement of primary and secondary streamers progressing from anode to cathode at slower speeds and lower luminous intensities than air at 760 mm. Unlike the case for air, the main stroke in Ar appears to move from anode towards the cathode. At 50 mm a somewhat diffuse spark channel did not reveal any streamer-like progession but the time scale was still in the 10^{-7} sec range. 1% air in Ar at 60 mm restored streamers. Purified Ar at 240 mm revealed a 2 mm wide diffuse channel breakdown occurring across the whole gap by a process unknown with a rise time of several microseconds and sustained luminosity for tens of μsec with no indication of streamers. This demonstrates the necessity of adequate photo-ionizable impurities in Ar for the development of the filamentary streamer spark transition.

10680 THE EQUILIBRIUM DISTRIBUTION OF CURRENT DENSITY IN STRAIGHT HIGH-CURRENT DISCHARGES.
L.M.Kovryzhnykh.
Atomnaya Energiya (USSR), Vol. 5, 648 (1958). In Russian.
English translation in: Plasma Phys–Accelerators–Thermonuclear Res. (GB), Vol. 1, No. 3, 147-8 (March, 1960).

Equations are derived for the electron and ion densities in a straight discharge chamber formed by two concentric cylinders. Along the common axis is a current carrying conductor. Cases are discussed for particular values of the current in the conductor.
J.W.Sturgess

10681 LIMITING BRIGHTNESS OF THE SPARK DISCHARGE CHANNEL. M.P.Vanyukov, A.A.Mak and A.I.Sadykova.
Dokl. Akad. Nauk SSSR, Vol. 135, No. 3, 557-9 (Nov. 21, 1960). In Russian.

For abstract, see Abstr. 5428 of 1961. [English translation in: Soviet Physics–Doklady (USA), Vol. 5, No. 6, 1237-9 (May-June, 1961)].

10682 NEW MATERIAL ON THE DEVELOPMENT OF THE CHANNEL OF A LONG SPARK.
I.S.Stekol'nikov and A.V.Shkilev.
Dokl. Akad. Nauk SSSR, Vol. 136, No. 4, 803-6 (Feb. 1, 1961).
In Russian.

For abstract, see Abstr. 5429 of 1961. [English translation in: Soviet Physics–Doklady (USA), Vol. 6, No. 2, 139-42 (Aug., 1961)].

10683 TIME-RESOLVED INTENSITY PATTERNS OF THE RADIATION FROM VARIOUS REGIONS OF A VACUUM SPARK DISCHARGE.
H.W.Jones, W.W.McCormick and R.A.Sawyer.
J. Opt. Soc. Amer., Vol. 51, No. 8, 833-7 (Aug., 1961).

Time-resolved intensity patterns of some lines of the second and third spectra of carbon from three different regions of a high-current vacuum spark discharge were studied. In any part of the discharge the intensity of both the spectral lines and the continuum depends upon the peak current and the inductance in the discharge circuit, while at a particular current and inductance the intensity is found to be largest in the cathode region, somewhat smaller in the central region, and smallest in the anode region of the discharge. Patterns from the central region exhibit less violent fluctuations than those from either of the other two regions. At currents above about 30 kA and an inductance of only 1.8 μH the contribution of the continuum to the total intensity is so large that the net line intensity either increased only slightly or actually decreased with increasing currents for all except the C III 4647 A line. Although they are well defined, the intensity differences from one region to another are not as large as might be expected in view of the large vapour particle velocities believed to exist in the discharge. The effect of the design of the spark chamber on the character of the discharge is discussed briefly.

10684 CONDITIONS OF APPEARANCE OF A LOW-PRESSURE STRIATED DISCHARGE. P.Kocian and J.Kracík.
Slaboproudy Obzor (Czechoslovakia), Vol. 22, No. 1, 16-19 (1961).
In Czech.

The conditions of appearance of a striated positive column in a low-pressure discharge in argon in the presence of heavy organic molecules were investigated experimentally. The heavy-molecule substance was P-85 (a solution of acetone, amylacetate and nitro-cellulose) and its partial pressure could be varied between 1 and 12 mm Hg. The currents (d.c. and a.c.) at which the striations appear and the voltages across the discharge tube were determined as a function of the total pressure and the partial pressure of P-85 for various partial pressures of A. The influence of the tube diameter on the formation of the striations was also determined. The results are shown in six graphs. It was found that, depending on the current and pressure, the positive column could be in the form of a helix or a number of separate striae. A rotating positive column could be observed at a certain critical current.
R.S.Sidorowicz

10685 EFFECT OF ELECTRICAL OSCILLATIONS ON THE ELECTRIC FIELD IN THE CATHODE DARK SPACE OF A COLD CATHODE GLOW DISCHARGE.
V.T.Chiplonkar and S.S.Maneck.
Current Sci. (India), Vol. 30, No. 3, 98-9 (March, 1961).

Reports measurements of the a.c. potential which occurs across a V/R 105 tube (carrying a d.c. glow discharge), when an a.c. signal (frequency 100 c/s to 100 kc/s) is injected into a circuit consisting of the V/R 105 and a load resistance. J.Dutton

SPECTROSCOPIC STUDIES OF IONIZATION IN A HOLLOW-CATHODE DISCHARGE. See Abstr. 10671

10686 ELECTRODE CONTAMINATION AND ARC FORMATION. H.de B. Knight.
Brit. J. appl. Phys., Vol. 12, No. 6, 282-7 (June, 1961).

When the surface of the cathode of a gas discharge is contaminated with insulating substances or with mercury, the discharge may develop into an arc with a lower voltage drop than when the contaminant is not present. Insulation particles are added to the electrodes of spark gaps designed to have a low impedance. With mercury, the minimum voltage and current values required for arc formation are lower the more effectively the mercury wets the electrode surface. Both contaminants play a part in the phenomenon of arc-back in arc rectifiers. The probability of arc-back depends on the random concentration of ions and also on the nature and extent of the contamination of the anode; this varies both with the conditions of operation and with previous treatment. The paper discusses the interpretation of tests made in "synthetic" circuits to determine the probability of arc-back in a rectifier in service.

10687 RESISTANCE HEATING IN THE ARC CATHODE SPOT ZONE. J.A.Rich.
J. appl. Phys. (USA), Vol. 32, No. 6, 1023-31 (June, 1961).

For an understanding of the arc cathode spot mechanism, it is essential to determine the relative importance of Joule heating within the cathode and the energy imput from the arc discharge. The problem of a source of uniform current density acting over a circular area on the surface of a semi-infinite solid of conducting material is formulated and solved with the following results: (1) The Joule heat developed in the hemispherical volume directly under the cathode spot amounts to 38% of the total Joule heat developed in the electrode. This concentration of the heating leads to high average power densities in the cathode spot zone which amount, in the case of mercury, to 5×10^7 and 5×10^9 W/cm^3 for current densities of 10^6 and 10^7 A/cm^2, respectively. (2) A comparison of the energy input to the cathode spot zone due to Joule heating and the energy input due to positive ion bombardment shows that for current densities of the order of 10^6 A/cm^2, the former amounts to some 10-20% of the latter for such high-resistivity metals as bismuth, antimony, and mercury. As the current density is increased to 10^7 A/cm^2, the two energy sources become comparable for metals other than the low resistivity metals such as copper and silver. (3) The time required to bring typical electrode materials to the melting point with resistance heating alone is relatively short. For $J = 10^8$ A/cm^2 and a spot radius of 2×10^{-3} cm, bismuth (271°C) requires 4 μsec, antimony (631°C) 35 msec. The boiling point of mercury (357°C) is reached in 18 μsec.

10688 ELECTRICALLY IMPLODED–EXPLODED ALUMINUM TUBE. E.C.Cnare.
J. appl. Phys. (USA), Vol. 32, No. 7, 1275-8 (July, 1961).

A high-energy exploding wire facility was used to investigate pinch effects in thin-walled aluminium tubing. The experiments carried out consisted of subjecting the tubing to the discharge of a 141 kJ capacitor bank and observing its motion by flash radiography and by high-speed sequential photography. Each tube first imploded uniformly, then broke down into an arc discharge in a manner similar to that of solid exploding wires. The implosion or pinch phase is adequately accounted for by the magnetic forces of the current discharge first acting against the mechanical strength of the tube walls and then, after melting, against the wall inertia and the retarding force of the air being compressed within the tube.

10689 PHENOMENA OCCURRING AT ELECTRICALLY STRESSED METALLIC SURFACES IN VACUUM.
R.Hawley and C.A.Walley.
Nature (GB), Vol. 190, 252-3 (April 15, 1961).

Direct optical observations of mass transfer between copper electrodes at pressures of $\sim 5 \times 10^{-5}$ torr and fields of $> 10^8$ V cm^{-1} during the pre-breakdown phase are reported. H.Mykura

10690 THE BREAKDOWN VOLTAGE OF MERCURY VAPOUR DISCHARGE CHAMBERS. T.Wasserrab.
Z. angew. Phys. (Germany), Vol. 13, No. 4, 194-201 (April, 1961). In German.

A discussion of the Townsend and more fully developed Mierdel–Steenbeck formula for breakdown is given and it is established that the breakdown curve for $pd > 1$ is not influenced by wall dimensions. By assuming a linear dependence between the secondary coefficient and electrode voltage an equation is obtained for breakdown which in the region of breakdown ($pd < 1$) corresponds quite well with known values for mercury. From the slope of the plotted equation, the values of minimum spark breakdown and minimum pd are obtained. Also obtained are the A and B constants of the Townsend equation. It is shown that the probability of sparking can be described by means of the Poisson equation. The permissible cut-off voltage for technical discharge chambers (Hg rectifiers) can be determined from the graph of the breakdown. H.Edel

10691 MECHANISM FOR PREBREAKDOWN CONDUCTIVITY IN VACUUM INTERELECTRODE GAPS. N.I.Ionov.
Zh. tekh. Fiz. (USSR), Vol. 30, No. 5, 561-7 (May, 1960). In Russia

The suggestion is made that the initiation of the initial conductivity of the gaps is due to thermionic emission (in the electric fie of positive ions from the anode and negative ions from the cathode This initial emission is intensified by secondary ion–ion emission and secondary ion–electron emission at the electrodes. The conditions for current stability and the development of an ion avalanche are given. The principle experimental results are found to be in qualitative agreement with this hypothesis. [English translation in: Soviet Physics–Technical Physics (USA), Vol. 5, No. 5, 527-32 (Nov., 1960)].

10692 OBSERVATIONS ON THE STRIATION OF ELECTRICALLY EXPLODED COPPER FOILS. E.C.Cnare.
J. appl. Phys. (USA), Vol. 32, No. 6, 1043-4 (June, 1961).

A high-energy exploding-wire facility was used to explode thin metallic foils electrically. Striation patterns are described for which the striation spacing appears to be dependent only on foil thickness and material. Magnetic probe measurements near the fo surface make evident the presence of shear currents in the foil whi are believed to be, in part, responsible for the striation phenomena The explanation of these striation phenomena may aid in explaining the striated appearance of exploding wires in general.

10693 ON THE MECHANISM OF EXPLODING WIRES. C.P.Nash and W.G.McMillan.
Phys. of Fluids (USA), Vol. 4, No. 7, 911-17 (July, 1961).

Experimental measurements are given for the energy input an shock-wave arrival times for 10 cm No. 40 Cu wires exploded in a at an initial voltage of 9.25 kV. Two shocks in air are observed, one for each pulse before and after the dark pause. Pause duration measurements are also reported for wire explosions in gaseous He N_2, O_2, Ar and $CCl F_3$ at 1 atm. Semiquantitative theoretical explan tions are porposed for the increase in wire resistance which termi nates the first current surge, and for the elapsed time (pause dura tion) before the vapour density of the expanding wire material declines sufficiently for re-ignition of the discharge.

PLASMA

(See also Magnetohydrodynamics)

10694 PLASMA ACCELERATION. THE FOURTH LOCKHEED SYMPOSIUM ON MAGNETOHYDRODYNAMICS.
Edited by S.W.Kash.
Stanford, California: Stanford University Press (1960) 117 pp.

The volume comprises the nine papers presented at the symposium, which was held at the Palo Alto Research Laboratory Dec. 2, 1959. The emphasis was placed on the acceleration of plasma for space propulsion. Abstracts of the papers will be found in this or succeeding issues of Physics Abstracts.

10695 SPACE DISPERSIVE PROPERTIES OF PLASMA. J.Neufeld.
Phys. Rev (USA), Vol. 123, No 1, 1-10 (July 1, 1961).

The "space dispersion", i.e., the occurrence of the term $\vec{k}$ in t dielectric constant $\epsilon(\omega, \vec{k})$, can be attributed either to the Doppler effect or to the magnitude of the term ak that may appear in the formulation of the problem. (a is a characteristic distance such as

Debye length). Using an approach based on the Doppler effect, macroscopic parameters of a plasma are represented in the m of four dimensional tensors of the fourth order (similar to se introduced by Mandelstam and Tamm). The phenomenological scription of plasma is also formulated in a three-dimensional ace by means of two macroscopic parameters: the electric sceptibility χ_e and the "proper magnetic susceptibility" χ_μ/μ. pressions for these parameters are given for the general case of lasma having an electron velocity distribution $f(\vec{v})d\vec{v}$ and for a v typical specific cases. Both parameters are functions of the equency and of the wave vector. This formulation brings into idence the fact that a plasma is a magnetically polarizable medium d the term χ_μ/μ vanishes only if the electron velocity distribution isotropic. In the current literature on the subject the existence the term χ_μ/μ has not been taken into account, since, by using a odified representation" of the dielectric constant, the magnetic operties of plasma have not been brought into evidence. In the odified representation" the dielectric constant ϵ_M is defined by e relationship $\vec{k} \times \vec{B} = -(\omega/c)\epsilon_M \vec{E}$, whereas in the conventional presentation the same relationship has the form

$$\vec{k} \times \vec{B} = -(\omega/c)\epsilon \vec{E} + 4\pi(\chi_\mu/\mu)\vec{k} \times \vec{B}$$

here $\epsilon = 1 + 4\pi\chi_e$). A general formalism is developed for deriving e electric and magnetic plasma parameters directly from the oltzmann–Vlasov equations.

10696 LIGHT AS A PLASMA PROBE. M.Baranger and B.Mozer.
hys. Rev. (USA), Vol. 123, No. 1, 25-8 (July 1, 1961).

The effect of longitudinal plasma oscillations on atomic spectra s examined. It is shown that they should give rise to satellite lines, isposed symmetrically in pairs about a forbidden line and separated rom it by Ω_p, the plasma frequency. Discussion is given of the ircumstances under which these satellites should be strong enough o be observed. Their observation would amount to a measurement f the frequency and intensity of plasma oscillations.

10697 VIRIAL EXPANSION FORMULAE FOR THE MICRO-FIELD AND MICROPOTENTIAL DISTRIBUTION UNCTIONS AND THEIR APPLICATION TO A HIGH TEMPERA-URE PLASMA. T.Morita.
rogr. theor. Phys. (Japan), Vol. 23, No. 6, 1211-13 (June, 1960).

By comparing the Fourier transforms of the distribution unctions of microfield and micropotential in high-temperature lasma with the interaction part of the chemical potential, the uthor suggests that the formalisms developed for the calculation f the chemical potential may be applicable to the calculation of ourier transforms of the distribution functions of microfield and nicropotential. This is illustrated by applying the virial expansion ormula for the chemical potential to the calculation of the distri-ution function of microfield in a plasma. M.S.Sodha.

10698 RADIATION FIELD AND Q OF A RESONANT CYLINDRICAL PLASMA COLUMN. W.D.Hershberger.
hys. of Fluids (USA), Vol. 4, No. 6, 740-2 (June, 1961).

A cylindrical plasma column displays a series of resonant esponses when it is excited by an electromagnetic wave with its lectric field and direction of propagation both perpendicular to the xis of the column. In the principal member of the mode spectrum, he electrons are taken to move in phase in a direction transverse o the axis of the column. The diameter of the column is small ompared to wavelength. In this paper, for the transverse electronic motion described, an expression for the vector potential in the region about the column is derived and thence the electromagnetic field components. The radiation field components E_ϕ and H_z vary as $\rho^{-1/2}$. The effect of radiation damping is calculated by deriving an expression for the selectivity factor Q. The expression is $Q = (\lambda/a)^2/2\pi^3$, when the radius a is much less than a wavelength.

10699 SPECTROSCOPIC METHODS FOR THE INVESTIGATION OF A HOT PLASMA.
A.N.Zaidel', G.M.Malyshev and E.Ya.Shreider.
Zh. tekh. Fiz. (USSR), Vol. 31, No. 2, 129-66 (Feb., 1961).
In Russian.

Complete and up-to-date survey of the subject, is treated in different sections corresponding to different physical approaches and technical problems involved. In every section there is a discussion of the theory and relevant experiments. 119 references are given. [English translation in: Soviet Physics—Technical Physics (USA)]. G.Martelli

10700 PLASMA COMPOSITION, PLASMA DENSITY, ENTHALPY AND SPECIFIC HEAT OF NITROGEN, NITRIC OXIDE AND AIR AT 1, 3, 10 AND 30 ATM. IN THE TEMPERATURE RANGE BETWEEN 1000 AND 30 000° K.
F.Burhorn and R.Wienecke.
Z. phys. Chem. (Germany), Vol. 215, No. 5-6, 269-84 (1960).
In German.

Tabulates these quantities after giving details of the basis for the calculations. C.G.Morgan

10701 PLASMA COMPOSITION, PLASMA DENSITY, ENTHALPY AND SPECIFIC HEAT OF HYDROGEN AND WATER VAPOUR AT 1, 3, 10 and 30 ATM. IN THE TEMPERATURE RANGE BETWEEN 1000 AND 30 000° K.
F.Burhorn and R.Wienecke.
Z. phys. Chem. (Germany), Vol. 215, No. 5-6, 285-92 (1960).
In German.

Continuation of previous work (see preceding abstract) tabulating the above quantities. C.G.Morgan

10702 GAS LAW AND CONDUCTIVITY OF A COLLISION-FREE PLASMA. O.Buneman.
Phys. of Fluids (USA), Vol. 4, No. 6, 669-80 (June, 1961).

The moment method is used to derive a form of two-component magneto-gas dynamics for a collision-free plasma. Closure of the moment equations is achieved by ignoring variations of fourth moments of the peculiar velocities for each component. This provides a "fully adiabatic gas law" which represents a generalization of the single or double adiabatic laws in that it predicts the gyrations of the pressure tensor, as well as the principal pressures. The currents which small perturbing electric fields cause to flow in each species in accordance with its own adiabatic gas dynamics are calculated. A complex conductivity tensor thus is deduced. This tensor is compared with that resulting from rigorous kinetic theory (without closure), for the case of a uniform plasma. It is found to be identical with the "warm plasma approximation" which takes into account temperature to first order. Hence a two-component fully adiabatic theory describes supersonic phenomena adequately but misses (altogether) the phenomenon of Landau damping. It could serve to provide pessimistic stability tests for nonuniform (confined) plasmas.

10703 EXACT RELATIVISTIC FOKKER–PLANCK COEFFICIENTS FOR PLASMA AND RADIATION. III.
A.Simon.
Phys. of Fluids (USA), Vol. 4, No. 6, 691-5 (June, 1961).

Exact relativistic Fokker–Planck coefficients have been derived earlier (Abstr. 7076 of 1961), for the case of a plasma composed of electrons and infinite mass ions. These results are now generalized to the case of an arbitrary number of finite-mass ion species.

DYNAMICS OF IONIZED GASES. See Abstr. 10665

EMISSION OF RADIO-FREQUENCY WAVES FROM PLASMAS. See Abstr. 10783

10704 RADIATION IN A PLASMA. I. ČERENKOV EFFECT.
M.H.Cohen.
Phys. Rev. (USA), Vol. 123, No. 3, 711-21 (Aug. 1, 1961).

The author starts with the linearized plasma equations containing an isotropic pressure term, plus extra source terms J^s and ρ^s in the Maxwell equations. The fields of (J^s, ρ^s) can be decomposed into two modes. The electromagnetic (EM) mode has all the magnetic field and no charge accumulation; it is the ordinary EM field of (J^s, ρ^s) in a dispersive medium of relative dielectric constant $\epsilon_r = 1 - (\omega_p/\omega)^2$. The plasma (P) mode has all the charge accumulation and no magnetic field; at great distances from the source, it becomes a longitudinal (radial) plasma wave with the usual dispersion relation for plane plasma waves. Various potentials for the EM and P modes are given by the inhomogeneous Klein–Gordon equation. The fields of a uniformly moving charged particle are found by a Lorentz transformation. When $(u/v_0) < 1$ (u = particle velocity, v_0 = r.m.s. thermal velocity), the EM and P fields are exponentially screened outside oblate spherioids foreshortened in the direction of motion. When $(u/v_0) > 1$, the P field exists only within the Mach (Cherenkov) cone trailing the particle. The frequency and angular spectra of the Cherenkov radiation are found, and the total radiated energy is found by assuming an arbitrary high-frequency cutoff due to Landau damping. The expression for total radiated energy agrees with that given by Pines and Bohm, except for the logarithmic terms.

10705 INTERACTION OF A STREAMING PLASMA WITH THE MAGNETIC FIELD OF A TWO-DIMENSIONAL DIPOLE. J.Hurley.
Phys. of Fluids (USA), Vol. 4, No. 7, 854-9 (July, 1961).

The interaction of a rarefied plasma stream and the magnetic field of a two-dimensional dipole was investigated assuming that the domain of interaction between the field and plasma stream is small. The dipole field is found to be confined to a cavity in the plasma, with the plasma constituents being specularly reflected from the cavity wall. The shape of the cavity wall and the magnetic field inside were determined. The interest of this problem lies in the analogous three-dimensional problem: the interaction between the solar wind and the earth magnetic dipole field.

10706 DETERMINATION OF HYDROMAGNETIC EQUILIBRIA. J.M.Greene and J.L.Johnson.
Phys. of Fluids (USA), Vol. 4, No. 7, 875-90 (July, 1961).

Hydromagnetic systems which employ the stellarator geometry provide one major approach to the controlled release of thermonuclear power and are a useful tool for laboratory studies of highly ionized gases. It is the purpose of this paper to study the problem of determining equilibrium configurations with such a toroidal geometry. Techniques for calculating hydromagnetic equilibria in toroidal systems which differ little from a uniform field are developed. The zeroth-order magnetic surfaces in these systems differ appreciably from concentric circular toroids. Care is taken to match on to reasonable fields at the plasma boundary. Expressions for various equilibrium properties including the rotational transform, the net current on each surface, and the magnetic lines of force are obtained. As an illustration of the theory it is shown that the application of a particular field perpendicular to the plane of the torus reduces the distortion associated with the introduction of pressure into the system.

10707 HYDROMAGNETIC STABILITY OF A TOROIDAL GAS DISCHARGE.
R.Lüst, B.R.Suydam, R.D.Richtmyer, A.Rotenberg and D.Levy.
Phys. of Fluids (USA), Vol. 4, No. 7, 891-901 (July, 1961).

The stability of a toroidal gas discharge is examined by using an energy principle. In the equilibrium configuration the plasma is assumed to have constant pressure and density. It is shown that the toroidal pinch can be stabilized under conditions which in most cases can be inferred, at least approximately, from knowledge of stability conditions for a cylindrical pinch.

10708 CONTAINMENT OF A PLASMA BY THE PRESSURE OF A STANDING ELECTROMAGNETIC WAVE.
R.Z.Sagdeev.
"Plasma physics", Vol. III (see Abstr. 5493 of 1960) p. 406-22.

A theoretical treatment in plane geometry of certain simple cases, using the collisionless Boltzmann equation. Firstly, shows that there is a stationary solution with only plasma at $+\infty$, and oscillatory electromagnetic yield at $-\infty$, provided the ion velocity distribution has an upper energy cut-off. Secondly, gives the electric and magnetic field and plasma density distribution in the transition region. Considers the cases when the particles move per cycle a distance both small and large compared to the skin depth. Thirdly, treats the case when the plasma is also imbedded in a uniform static magnetic field. Fourthly, considers the stability of the boundary, and shows that it becomes unstable for pertubation wavelengths comparable with that of the standing electromagnetic wave. R.S.Pease

10709 THEORY OF THE SLOW PINCH DISCHARGE. I. MAGNETOHYDRODYNAMIC STABILITY OF THE DISCHARGE CORE. A.A.Ware.
Phys. Rev. (USA), Vol. 123, No. 1, 19-24 (July 1, 1961).

Among the unexplained properties of the slow pinch discharge observed in Zeta, Sceptre, and other experiments is the gross magnetohydrodynamic stability of the discharge. Since the pinch of the magnetic lines of force is approximately constant within the main core of these discharges, the energy principle is applied to such a configuration. The stability condition for interchange modes is

$$dp/dr \geq -2\gamma p B_\theta^2/r(B^2 + \gamma p)$$

and, for kink modes, dp/dr should be greater than an undetermined positive quantity. Comparison with experimental results suggests that interchange instabilities are occurring and limiting the negative pressure gradient to the above value, whereas the kink modes can be occurring with, at most, only small amplitude. Possible reasons are given to explain why the kink instability is not observed.

10710 SELF-CONSISTENT REVERSED FIELD SHEATH. R.C.Mjolsness, F.L.Ribe and W.B.Riesenfeld.
Phys. of Fluids (USA), Vol. 4, No. 6, 730-5 (June, 1961).

An analytic solution is obtained for the structure of a prototy reversed field sheath. The configuration is a region of uniform (direct) magnetic field separated from a second region of uniform (reversed) field of equal magnitude but opposite sign by a current sheath of finite width composed of zero-temperature plasma. Growth rates of certain instabilities of the system are calculated. It is found that the modes considered do not grow as rapidly as th plasma frequency, but the growth rates may still be quite large. Finally, a qualitative discussion is given of the results to be expected when the reversed field is opposed by a direct field of larger magnitude.

10711 STABILITY OF A PLASMA BOUNDARY IN A MAGNETIC FIELD. B.Lehnert.
Phys. of Fluids (USA), Vol. 4, No. 7, 847-54 (July, 1961).

The stability of a plasma confined by a magnetic field has be discussed by Rosenbluth and Longmire in terms of particle orbits and the results applied to a plasma separated from vacuum by a sharp boundary which is rippled by a sinusoidal perturbation. Th earlier theory is reconsidered and extended to include the effect a finite density gradient. Drift motions along the boundary are al discussed for displacements comparable to and exceeding the wa length of the perturbation. For small wavelengths it is found tha the plasma is stable against small flute deformations not only for magnetic field which is convex towards the plasma but also for a field which is concave towards the plasma, provided that the latte has a sufficiently strong gradient and that the density distribution not too steep. Even in the unstable case the growth rate is reduc very much compared to the situation studied by Rosenbluth and Longmire. The result provides a possible explanation of the obse stability of the Van Allen radiation belts and in experiments with magnetic mirrors and rotating plasma devices.

10712 INJECTION AND TRAPPING OF A $\beta = 1$ PLASMA IN A CUSPED MAGNETIC FIELD.
D.C.Hagerman and J.E.Osher.
Phys. of Fluids (USA), Vol. 4, No. 7, 905-11 (July, 1961).

An experiment using a plasma gun as a source to inject a hig velocity jet of plasma into a picket fence magnetic confinement system is described. The results show that a plasma jet having 5×10^{13} deuterons/cm^3 and a mean directed kinetic energy of 1 k deuteron is able to traverse a 2 kG magnetic barrier displacing t field completely in its path, i.e. travelling as a $\beta = 1$ plasma (β i defined as the ratio of the material pressure within the plasma to magnetic field pressure confining the plasma). Some focusing of the plasma jet occurs during the penetration which increases its sity. If the plasma is injected into a higher field it mixes with th field and penetrates as a $\beta < 1$ plasma. These two phenomena co bine so that the idealized sudden stopping of a given beam at a critical magnetic field ($B_c^2 > 12\pi\rho V^2$) is not observed. For field < 2000 gauss the plasma jet opens the entrance cusp for $\cong 3$ μsec biconical diamagnetic region with $\beta = 1$ builds up within the picke fence volume and then decays with a time constant of 50 μsec. T indicates that some irreversible process does occur, trapping pla within the magnetic confining field.

10713 A RESONANCE METHOD FOR LOCALISING AND HEATING A PLASMA BY MEANS OF A VARYING ELECTROMAGNETIC PRESSURE.
G.A.Askaryan and M.S.Rabinovich.
Atomnaya Energiya (USSR), Vol. 5, 643 (1958). In Russian.
English translation in: Plasma Phys—Accelerators—Thermonuc Res. (GB), Vol. 1, No. 3, 143-4 (March, 1960).

It is suggested that a spheroidal plasma bunch can be heated an intense modulated electromagnetic field, the modulation being produced by a magnetic field varying rapidly and randomly. Vol oscillations will occur if the modulation frequency is close to the acoustical resonant frequency of radial pulsations. Large amplit oscillations arise if the period of the external excitation varies w the period of pulsation of the bunch. An order of magnitude calculation of the ratio of maximum external pressure used to maximum internal pressure obtainable is given. J.W.Sturg

10714 EQUILIBRIUM AMBIPOLAR POTENTIALS IN A MIRROR MACHINE. R.F.Post.
Phys. of Fluids (USA), Vol. 4, No. 7, 902-5 (July, 1961).

A plasma confined in a mirror machine can be expected to develop an electrostatic potential with respect to its surrounding This potential arises because of the intrinsically different rate o

ffusion in velocity space of the electrons and ions. When the mperature of the confined electrons is comparable to or smaller an the ion temperature, the potential will be positive, and will vary thin the plasma. The variation of plasma potential with position in mirror machine is calculated for conditions where: (a) the elec- on temperature is small compared to ion temperature and (b) elec- ons and ions are separately in diffusion equilibrium with the irror losses. It is shown in an example that the plasma potential nds to concentrate near the mirrors, and that its variation, be- ween the mirrors, is relatively insensitive to the total potential. pplications and extensions of the calculations are suggested.

10715 EXPERIMENTS IN STEADY STATE CROSSED-FIELD ACCELERATION OF PLASMA.
.P.Wood, A.F.Carter, A.P.Sabol and R.A.Weinstein.
hys. of Fluids (USA), Vol. 4, No. 5, 652-3 (May, 1961).

Reports a successful operation of a steady-state crossed-field lasma accelerator at moderately high density of plasma. The per- ormance of the accelerator is in approximate agreement with the eory (Wood and Carter, Dynamics of Conducting Gases. vanston, Illinois: Northwestern University Press (1960) p. 209).
M.S.Sodha

10716 PLASMA AS A MICROWAVE AMPLIFIER. S.Rand.
hys. of Fluids (USA), Vol. 4, No. 7, 860-5 (July, 1961).

A mechanism is postulated for which a streaming plasma may ransmit energy to a traversing radiation field, and thereby enhance he signal. For a laboratory plasma, only resonance frequencies ver a narrow band may be amplified by this method. Large ampli- ication over a broad frequency range is postulated for an astronom- cal gas.

10717 "CORKSCREW" - A DEVICE FOR CHANGING THE MAGNETIC MOMENT OF CHARGED PARTICLES IN A MAGNETIC FIELD. R.C.Wingerson.
Phys. Rev. Letters (USA), Vol. 6, No. 9, 446-8 (May 1, 1961).

A helix gives rise to a field which can perturb an initially axial field causing a steady change in the transverse energy of particles in the field, and hence their magnetic moment. This may allow trapping of a high-energy beam injected axially into a mirror device. There must be a close match between the pitch of the helix locally and the particle trajectory. The particles are thus trapped by a resonance effect whereas losses will occur by random scattering. It is hoped that the difference between trapping and loss mechanisms will allow increased containment times by modifications to the basic configuration. The necessary equations are derived briefly. Trapping was observed in experi- ments on an electron beam.
J.W.Sturgess

10718 ON THE BEHAVIOUR OF SMALL PLASMA BUNCHES IN A WAVEGUIDE AND THEIR INTERACTION WITH THE CONDUCTING WALLS. G.A.Askaryan.
Atomnaya Energiya (USSR), Vol. 5, 644 (1958). In Russian.
English translation in: Plasma Phys—Accelerators—Thermonuclear Res. (GB), Vol. 1, No. 3, 144-5 (March, 1960).

The radial forces acting on a small plasma bunch are calculated for E_0 and H_0 waves when the bunch is displaced a distance greater than its dimensions. An estimate is also made of the strength of interaction of the bunch with the walls. The existence of several types of guides and reflectors for bunches is mentioned.
J.W.Sturgess

10719 THE CONFINEMENT OF SHOCK-HEATED PLASMAS IN MIRROR MAGNETIC FIELDS.
J.K.Wright and N.J.Phillips.
Plasma Phys—Accelerators—Thermonuclear Res. (GB), Vol. 1, No. 4, 240-3 (July, 1960).

Discusses the action of a Scylla type device and points out the difference between it and a mirror machine. The application of a reverse bias field is considered to give rise to closed loops of field in the plasma. These disappear rapidly eliminating trapped field in the plasma and hence lead to increased containment times, express- ions for which are derived.
J.W.Sturgess

10720 END LOSS IN THE LINEAR Θ-PINCH. K.V.Roberts.
Plasma Phys—Accelerators—Thermonuclear Res. (GB), Vol. 1, No. 4, 243-4 (July, 1960).

Alternative configurations from the previous paper are considered in which some magnetic lines, which pass through the mirror, are mixed in the plasma. The rate of plasma loss is estimated. A severe restriction on cusp geometry is emphasized; that is that only a negligible quantity of flux from the enclosed plasma may pass through the cusps.
J.W.Sturgess

10721 EFFECTS OF IONIZATION AND MAGNETIC INITIAL CONDITIONS ON A MAGNETICALLY COMPRESSED PLASMA (SCYLLA). E.M.Little, W.E.Quinn and F.L.Ribe.
Phys. of Fluids (USA), Vol. 4, No. 6, 711-30 (June, 1961).

The effects of strong preionization and the application of steady bias magnetic fields on the operation of the magnetic compression device Scylla are studied. It is shown that both strong preionization and a bias field B_0 antiparallel to the main compression field B_Z are necessary to produce neutrons during the first half-cycle of B_Z. Other aspects of the plasma activity are also shown to depend strongly upon the sign of B_0. Application of bias fields with weak preionization leads to production of hard X-rays which occur on the half-cycle of the discharge which precedes that of neutron emission. When hard X-rays are produced the plasma is not hydromagnetic. The hard X-rays are extinguished when there is strong preionization, leading to a hydromagnetic plasma. In the case of the hydromagnetic plasma it is concluded that antiparallel B_0 plays its role early in a given half-cycle and affects the plasma primarily during its preheating, ionization phase, rather than during the adiabatic-compression phase which follows it. An interpretation is given in terms of a plasma sheath which has special properties when it separates magnetic fields of opposite signs.

10722 ELECTRIC-FIELD-INDUCED ANISOTROPIES IN AN INHOMOGENEOUS PLASMA. L.Wetzel.
Phys. Rev. (USA), Vol. 123, No. 3, 722-6 (Aug. 1, 1961).

It is shown on the basis of the Boltzmann equation that in the absence of a d.c. magnetic field, an electric field alone can produce anisotropies in electron diffusion and conductivity in a weak inhomogeneous plasma. These anisotropies have their origin in the a.c. component of the electron density resulting from the interaction between the electric field and electron density gradients. Electron diffusion is reduced in the direction of the field, while the induced a.c. current acquires an additional component in the direction of the gradient of the a.c. electron density. This component will in general lie in a direction different from that of the exciting field. Although these effects are usually small, they may become significant under suitable circumstances.

10723 RADIATION BY CHARGED PARTICLES PASSING THROUGH AN ELECTRON PLASMA IN AN EXTERNAL MAGNETIC FIELD. S.K.Majumdar.
Proc. Phys. Soc. (GB), Vol. 77, Pt 6, 1109-20 (June, 1961).

The motion of a charged particle through a low-density electron plasma in an external magnetic field was investigated. The interaction of the particle through transverse waves only was considered, and the consequent energy losses are calculated. It is found that the coupling between the longitudinal plasma wave and the transverse electromagnetic wave modifies the nature of radiation emitted by the particle. The results show that for a velocity greater than that needed for exciting plasma waves in the medium, the particle emits non-Cherenkov type of radiation, in addition to Cherenkov radiation obtained previously by others.

Plasma Oscillations

10724 PLASMA OSCILLATIONS IN A MAGNETIC FIELD. I.Kaji and M.Kito.
J. Phys. Soc. Japan, Vol. 15, No. 10, 1851-61 (Oct., 1960).

In the presence of a uniform external magnetic field, the initial value problem for a longitudinal electron oscillation in a fully ionized plasma is treated in the range of the linear theory under the assumption that collisions are negligible and that the angle θ between wave vector and magnetic field is not equal to $\pi/2$, and $\mathrm{Re}(s) \neq 0$ on the complex s-plane. It is shown that, if the indicial condition that the solution of initial value problem varies as $\exp(i\mathbf{k}\cdot\mathbf{r} + \alpha t)$ is determined, where α is a complex valued frequency, then for $\mathrm{Re}(\alpha) < 0$ (damped wave) there appears an indeterminancy in the dispersion equation of the potential and for $\mathrm{Re}(\alpha) > 0$ (amplified wave) each dispersion equation of the proper plasma oscillations, the perturbed velocity distribution function, and the potential are coincident. As a typical example, the case in which the equilibrium distribution is Maxwellian is discussed.

10725 RADIO EMISSION BY PLASMA OSCILLATIONS IN NONUNIFORM PLASMAS. D.A.Tidman and G.H.Weiss.
Phys. of Fluids (USA), Vol. 4, No. 6, 703-10 (June, 1961).

The electromagnetic radiation emitted when a field of longi-

tudinal plasma oscillations is incident on a localized fluctuation in density in a plasma is calculated. Use is made of the collisionless Boltzmann equation to describe the electron component of the plasma and compare the results with those previously obtained using the moment equations for this problem.

10726 RADIATION BY A LARGE-AMPLITUDE PLASMA OSCILLATION. D.A.Tidman and G.H.Weiss.
Phys. of Fluids (USA), Vol. 4, No. 7, 866-8 (July, 1961).

A plasma oscillation which is initially purely longitudinal in a plasma of zero temperature is considered and the amount of electromagnetic radiation produced by the wave is then determined using second-order perturbation theory.

10727 ON LANDAU DAMPING. J.Dawson.
Phys. of Fluids (USA), Vol. 4, No. 7, 869-74 (July, 1961).

The problem of Landau damping of longitudinal plasma oscillations is investigated by dividing the plasma electrons into two groups. The first group is the main plasma and consists of all electrons with velocities considerably different from the wave velocity while the second group, the resonant electrons, consist of all electrons with velocities near the wave velocity. It is assumed that initially the main plasma has a wave on it while the resonant particles are undisturbed. It is shown that equating the gain in energy of the resonant particles to the loss in energy of the wave gives the correct Landau damping. Only first-order quantities are used in the analysis so that particle trapping which is a nonlinear effect is not involved. The validity of arguments which attribute Landau damping to particle trapping is discussed. The breakdown of the linearized theory and the Galilean invariance of the damping are also investigated.

10728 A POSSIBLE NON-STATIONARY THERMONUCLEAR REACTOR. E.Larish.
Atomnaya Energiya (USSR), Vol. 5, 646 (1958). In Russian.
English translation in: Plasma Phys—Accelerators—Thermonuclear Res. (GB), Vol. 1, No. 3, 146-7 (March, 1960).

A cylindrical or spheroidal plasma column is considered to perform forced radial oscillations under the influence of an external alternating magnetic field. The condition for periodicity of the oscillations is derived and it is shown that for this to be satisfied the nuclear energy generated in one cycle considerably exceeds the radiative energy. J.W.Sturgess

ELECTRON EMISSION
ELECTRON BEAMS

10729 AN OXIDE CATHODE WITH A NICKEL—TANTALUM ALLOY BASE. Yu.G.Ptushinskii.
Fiz. tverdogo Tela (USSR), Sbornik [Supplement] II, 317-18 (1959). In Russian.

Addition of 1% Ta to a nickel base of a BaO-coated cathode produced emission currents (453 mA/cm^2 at 750°C) which were intermediate in magnitude between the currents produced by cathodes with bases of Ni + 2% Si (166 mA/cm^2) and with Ni + 5% W (830 mA/cm^2). Addition of 0.5 or 4% Ta to nickel also produced good results. A.Tybulewicz

10730 THE PHOTOELECTRIC EFFECT IN METALLIC CATHODES IN THE WAVELENGTH RANGE 1.39 TO 13.3 A. M.A.Rumsh, A.P.Lukirskii and V.N.Shchemelev.
Dokl. Akad. Nauk SSSR, Vol. 135, No. 1, 55-7 (Nov. 1, 1960). In Russian.

For abstract, see Abstr. 4634 of 1961. [English translation in: Soviet Physics—Doklady (USA), Vol. 5, No. 6, 1231-3 (May-June, 1961)].

10731 BISMUTH—SILVER—OXYGEN—CESIUM PHOTOCATHODE. A.H.Sommer and W.E.Spicer.
J. appl. Phys. (USA), Vol. 32, No. 6, 1036-42 (June, 1961).

The Bi—Ag—O—Cs photocathode has been used for many years because of its high and reasonably uniform sensitivity throughout the visible spectrum. Chemical and physical studies are reported which were made to gain an understanding of the chemical nature and of the energy band model of the material. It was found that the Bi—Ag—O—Cs cathode consists of the semiconductor Cs_3Bi, elementary Ag, one or more Cs oxides, and possibly some elementary Cs. The Ag, but not the Bi, can be replaced by several other metals. Energy band models were determined by using considerations wh have been successful in the interpretation of the alkali antimonic photoemitters. From optical and photoelectric measurements, values for band-gap energy and electron affinity were thus obtain for Cs_3Bi as well as for the more complex materials represente the symbols $Cs_3Bi(O)$, $Cs_3Bi(Ag)$, and Bi—Ag—O—Cs. A band ga approximately 0.7 eV was found for all of these materials. It wa shown that the oxygen reduces the electron affinity of Cs_3Bi fro 1.3 to 1.0 eV but does not greatly enhance the photoelectric yield The addition of Ag to Cs_3Bi or $Cs_3Bi(O)$ greatly increases the yi without appreciably reducing the electron affinity. A hypothesis suggested to explain these effects.

10732 TEMPERATURE-DEPENDENT BISMUTH—CESIUM PHOTOSURFACES. R.J.Zollweg and C.R.Taylor.
J. appl. Phys. (USA), Vol. 32, No. 7, 1316-19 (July, 1961).

The yield of bismuth—caesium photosurfaces is sometimes strongly temperature dependent. Investigations were made on th effect and it was found to be dependent upon the presence of oxyg and upon the size of the aggregates making up the photosurface. photoelectron energy spectra were also examined. It is conclude that the temperature dependence probably arises from a change escape depth with temperature because of phonon collisions, but the principal photoelectron energy loss may occur at oxygen imp sites.

10733 SPECTRALLY SELECTIVE (SOLAR BLIND) U.V. PHOTOMULTIPLIERS WITH FLUORIDE WINDOWS. A.H.Sommer.
Rev. sci. Instrum. (USA), Vol. 32, No. 3, 356 (March, 1961).

The construction of a photomultiplier with a quantum efficie of the order of 10% for radiation in the range 1100 to 2200 A is described. A cathode of caesium telluride is used, which has negligible light absorption and photo-emission in the visible part the spectrum. Lithium fluoride or calcium fluoride windows (transparent to the far ultraviolet) are used, sealed to glass by silver chloride cement. J.L.Redd

10734 ON CERTAIN REGULAR FEATURES OF THE SECONDARY ELECTRON EMISSION OF THIN LAYERS OF METALS AND SEMICONDUCTORS.
I.M.Bronshtein and B.S.Fraiman.
Dokl. Akad. Nauk SSSR, Vol. 135, No. 5, 1097-1100 (Dec. 11, 196 In Russian.

For abstract, see Abstr. 4637 of 1961. [English translation Soviet Physics—Doklady (USA), Vol. 5, No. 6, 1273-6 (May-June, 1961)].

10735 ON THE THEORIES OF SECONDARY ELECTRON EMISSION OF METALS. II.
G.Bimschas and G.U.Schubert.
Z. Phys. (Germany), Vol. 162, No. 4, 382-99 (1961). In German.

For Pt I see Abstr. 5493 of 1961 . Elastic scattering of secondaries is considered and a transport equation evolved. Inelastic scattering is treated as being effectively absorption. The calculations lead to an inhomogeneous Milne integral equatio solved by considering various boundary conditions by the Wiener—Hopf method. The ratio of free path lengths for elastic and inelastic scattering is obtained as a parameter and could be decided by suitable experiments. G.F.J.Garl

10736 THE INFLUENCE OF MECHANICAL STRAIN ON TH SECONDARY ELECTRON EMISSION FROM BERYLL OXIDE. A.M.Tyutikov.
Dokl. Akad. Nauk SSSR, Vol. 136, No. 5, 1063-5 (Feb. 11, 1961). Russian.

For abstracts, see Abstr. 7093 of 1961. [English translatio Soviet Physics—Doklady (USA), Vol. 6, No. 2, 156-8 (Aug., 1961)]

10737 EFFECTS OF MONOLAYER ADSORPTION AND BOMBARDMENT DAMAGE ON AUGER ELECTRON EJECTION FROM GERMANIUM. H.D.Hagstrum.
J. appl. Phys. (USA), Vol. 32, No. 6, 1015-19 (June, 1961).

Data are presented which show how the adsorption of carbon monoxide and oxygen on atomically clean germanium affect the process of Auger nuetralization of He^+ and Ne^+ at the surface. Measurements of both total yield and kinetic-energy distribution of ejected Auger electrons were made. The effect of ion bombar ment alone without subsequent anneal, including the presence of absorbed noble gas in the surface layers of the crystal, was investigated. Photomicrographs of the germanium target surfac reproduced.

10738 RESISTANCE STRIP MAGNETIC ELECTRON MULTIPLIER. G.W.Goodrich and W.C.Wiley.
v. sci. Instrum. (USA), Vol. 32, No. 7, 846-9 (July, 1961).

A magnetic electron multiplier which utilizes a strip of semiiductor material rather than a conventional multi-element dynode ucture is described. Especially suitable for use in demountable cuum systems, it amplifies and detects the electrons which result m bombardment of the cathode with ions, neutral molecules, otons, etc. Gains over 10^7, and dark currents lower than 0.1 elecn per second referred to the cathode, were obtained. The addition crossed field gates to rapidly direct the output beam to any one several output anodes is discussed. Theory of operation and reIts of experimental measurements are reported.

10739 NOTES ON THE USE OF A RUBBER MEMBRANE MODEL FOR PLOTTING ELECTRON TRAJECTORIES.
).White and D.L.Perry.
v. sci. Instrum. (USA), Vol. 32, No. 6, 730-2 (June, 1961).

Experimentation with a rubber membrane analogue disclosed irces of error in the technique which do not seem to be generally cognized. Means for reducing these errors are discussed and mparisons of observed and computed trajectories for a particular ctrode system illustrate the improvement to be expected.

10740 IMPROVED ELECTRON FILTER LENS. J.A.Simpson and L.Marton.
ev. sci. Instrum. (USA), Vol. 32, No. 7, 802-3 (July, 1961).

An electrostatic filter lens of improved characteristics obtained r use of an intermediate image is described. The design has the lvantage of longer focus and increased aperture while maintaining energy resolution, at 5 keV primary energy, of less than thermal read of the initial beam.

DEVELOPMENT OF AN ELECTRON OPTICAL METHOD OF AKING MAGNETIC MEASUREMENTS. See Abstr. 10758-9

10741 MEASUREMENT OF OBJECT TEMPERATURE IN THE ELECTRON MICROSCOPE USING ELECTRON IFFRACTION. L.Reimer, R.Christenhuss and J.Ficker.
laturwissenschaften (Germany), Vol. 47, No. 20, 464 (Oct., 1960).
n German.

Heating stages may be calibrated by measuring the temperature ariation of the ring diameters in the Debye—Scherrer pattern of hin layers of evaporated metal. The method is simple and appears o be of high accuracy. A layer of Ni evaporated at 200° C to a hickness of 300 A is preferred, being useful for temperatures elow 700° C. Selected area diffraction of a small hole is used and he ring diameters can be measured to 1/100 mm with a viewing nicroscope. R.Reed

ION EMISSION . ION BEAMS

10742 ION-FOCUSING PROPERTIES OF A THREE-ELEMENT QUADRUPOLE LENS SYSTEM. H.A.Enge.
Rev. sci. Instrum (USA), Vol. 32, No. 6, 662-6 (June, 1961).

Results of thick-lens calculations are presented in the form of graphs showing the field-strength parameters and magnifications, as functions of object and image distances.

10743 ELECTROSTATIC ANALYZER WITH VARIABLE FOCAL LENGTH. H.Matsuda.
Rev. sci. Instrum. (USA), Vol. 32, No. 7, 850-2 (July, 1961).

A method for the electrical control of the focal length of an electrostatic particle analyser (as used in mass spectrographs) is proposed. The focal length of the apparatus depends on the shape of the electric field, and the electric field in the cylindrical condenser of finite length may be modified by changing the potential near the edges of the condenser. A 90° electrostatic analyser for such a purpose was constructed and the focusing character of this apparatus was investigated. The electrode assembly of the analyser consists of two cylindrical condenser electrodes of finite length and two auxiliary plates near both edges. It was possible to focus a sharp radial image and a sharp axial image on a fluorescent screen at any location by applying a suitable potential to the auxiliary plates.

10744 REFLECTION OF NOBLE GAS IONS AT SOLID SURFACES. H.D.Hagstrum.
Phys. Rev. (USA), Vol. 123, No. 3, 758-65 (Aug. 1, 1961).

A method was developed for distinguishing the reflection of ions at solid surfaces as ions or as metastable atoms. Results are given for He^+, Ne^+, and A^+ ions incident on clean W, Mo, and Si(100) and on contaminated W, Hf, and Ge(111) surfaces. The reflection coefficient of ions to ions (R_{ii}) is found to be small (0.0004 to 0.002) and essentially independent of incident-ion energy. The reflection coefficient of ions to metastable atoms (R_{im}) is found to increase with ion energy from values comparable to R_{ii} at 10 eV to values as high as 0.04 at 1000 eV. Discussion of these results is given in terms of the known resonance and Auger transitions which can occur near a solid surface for ions of sufficiently large ionization energy. It is shown that the results can be accounted for only if ions are transformed to metastable atoms very close to the surface, and a possible mechanism for this process is proposed.

10745 ANISOTROPY OF CATHODIC SPUTTERING OF SINGLE CRYSTALS.
V.A.Molchanov, V.G.Tel'kovskii and V.M.Chicherov.
Dokl. Akad. Nauk SSSR, Vol. 137, No. 1, 58-9 (March 1, 1961).
In Russian.

Sputtering from the (100) planes of single Cu and Ni crystals, bombarded with low energy (27 eV) A ions, was studied. The graphs, obtained by plotting the number of metal atoms sputtered on against the angle of incidence of the ion beam, had two minima at approximately 35 and 55°. This indicated that the sputtering coefficient is at its minimum when the direction of the incident ion beam coincides with the direction of one of the principal, i.e. (100), (111), and (112), crystallographic axes of the target. [English translation in: Soviet Physics — Doklady (USA)]. M.H.Sloboda

10746 MULTIPLE CATHODE SPUTTERING SYSTEM. J.G.Simmons and L.I.Maissel.
Rev. sci. Instrum. (USA), Vol. 32, No. 6, 642-5 (June, 1961).

Describes a versatile system which incorporates several cathodes and a rotating anode, making it possible to sputter one metal after another without breaking the vacuum and to deposit films of various thicknesses under identical conditions.

PARTICLE ACCELERATORS

ACCELERATORS IN BIOLOGY AND MEDICINE. See Abstr. 10343

10747 CALCULATION OF THE PHASE TRAJECTORIES OF CHARGED PARTICLES TAKING INTO ACCOUNT THE COULOMB INTERACTION IN THE BUNCHER OF THE LINEAR ELECTRON ACCELERATOR. S.P.Lomnev.
Dokl. Akad. Nauk SSSR, Vol. 135, No. 4, 822-4 (Dec. 1, 1960).
In Russian.

For abstract, see Abstr. 4676 of 1961. [English translation in: Soviet Physics—Doklady (USA), Vol. 5, No. 6, 1264-6 (May-June, 1961)].

10748 A 150 kV ION ACCELERATOR. M.Mangialajo, P.Principi and F.Tonolini.
Energia nucleare (Italy), Vol. 8, No. 4, 237-42 (April, 1961).
In Italian.

A 150 kV accelerator for the production of atomic and molecular ion beams and their acceleration was designed and built. Beside being of simple construction and functioning, it offers the possibility of obtaining currents of the order of a mA. The radiofrequency ion source with axial magnetic field permits the extraction a current of 2 mA. The machine can be employed as an ion injector for plasma physics and for studies on elementary collision phenomena in atomic physics. The accelerator can be used as a 14 MeV neutron generator, through the well known reaction $T(d, n)He^4$, in nuclear physics allowing intensities of 10^9-10^{10} neutrons/sec to be obtained.

10749 HEAVY-ION LINEAR ACCELERATOR. E.L.Hubbard, W.R.Baker, K.W.Ehlers, H.S.Gordon, R.M.Main, N.J.Norris, R.Peters, L.Smith, C.M.Van Atta, F.Voelker, C.E.Anderson, R.Beringer, R.L.Gluckstern, W.J.Knox, M.S.Malkin, A.R.Quinton, L.Schwarcz and G.W.Wheeler.
Rec. sci. Instrum. (USA), Vol. 32, No. 6, 621-34 (June, 1961).

Two linear accelerators were built for the acceleration of ions in the mass region from helium to argon. The linear accelerators

consist of two 70 Mc/s cavity resonators of the Alvarez design [Phys. Rev. (USA), Vol. 58, 192 (1940)]. Ions with a charge to mass ratio $e/m \simeq 0.15$ times the e/m of a proton were injected into the first cavity of the linear accelerator with a Cockroft–Walton accelerator. In the first cavity the ions were accelerated from the injection energy of 0.07 MeV/nucleon to 1.0 MeV/nucleon. They were then stripped to an $e/m \simeq 0.3$ and accelerated to the final energy of 10 MeV/nucleon in the second linac cavity.

10750 ON THE UNCERTAINTY OF SEMIRELATIVISTIC CIRCULAR ELECTRON ACCELERATORS WITH CONSTANT-TIME FIELD. L.Krlin.
Czech. J. Phys., Vol. 10, No. 4, 334-5 (1960). In German.

The hitherto impossible simultaneous realization of betatron oscillation stability and electron revolution period constancy in circular electron accelerators with constant-time field is now made possible by a series of approximations in different cases, which circumvent the uncertainty occurring. It is demonstrated that several factors may be neglected in actual equilibrium paths, thus permitting approximated computations in analogy to customary approximation methods. L.Mordecai

10751 ON "SUPERPOSED" ACCELERATORS. E.M.Moroz.
Atomnaya Energiya (USSR), Vol. 6, 660 (1959). In Russian.
English translation in: Plasma Phys.—Accelerators—Thermonuclear Res. (GB), Vol. 1, No. 4, 275-6 (July, 1960).

The possibility of accelerating protons and electrons simultaneously in the same machine is discussed. Methods are indicated to overcome the interaction of the proton bunch with the electron resonator field. J.W.Sturgess

10752 THE EFFECT OF A SPACE CHARGE ON THE MOTION OF PARTICLES IN ACCELERATORS. V.I.Kotov and V.A.Pushtarik.
Atomnaya Energiya (USSR), Vol. 7, 268 (1959). In Russian.
English translation in: Plasma Phys—Accelerators—Thermonuclear Res. (GB), Vol. 1, No. 4, 276 (July, 1960).

It is shown that the screening effect of the walls of the chamber and the iron in the electromagnet in the non-relativistic case produces a change in frequency of free oscillations of 10 to 20%. In the relativistic case the effect becomes much more important and may lead to restrictions on the possible number of bunches which may be accelerated. J.W.Sturgess

X-RAY TUBES AND TECHNIQUES

10753 RECENT DEVELOPMENTS IN INDUSTRIAL RADIOGRAPHY: FLUOROSCOPY AND SCREEN-INTENSIFICATION PROCESSES. R.Halmshaw.
Progress in non-destructive testing. Vol. 1 (see Abstr. 9238 1961) p. 1-31.

This review article discusses experimental work on the sensitivity limits attainable in X-ray screen fluoroscopy and with various types of image intensifiers, particularly the Philips type, and it considers the factors limiting the performance. The sensitivity limits imposed by the effect of quantum fluctuations in the X-ray beam are considered. 50 references are given. J.B.Birks

10754 APPARATUS DRAWINGS PROJECT. REPORT NUMBER 17. SMALL X-RAY TUBE.
Amer. J. Phys., Vol. 29, No. 7, 445-50 (July, 1961). R.G.Marcley.

A small well-shielded high-vacuum molybdenum-anode X-ray tube designed for use as an ionizing source with a Millikan oil-drop apparatus is described. An accelerating potential of 28 kV peak provides a continuous X-ray spectrum with a short-wavelength cut-off of 0.436 A as well as the intense K, L, M, and N series of the characteristic line spectrum of molybdenum. The 28 kV accelerating potential, with a saturation current of 0.2–0.3 mA r.m.s., ensures adequate ionization with conventional equipment, while still permitting the convenient installation of the massive external shielding necessary in a teaching laboratory. Information on essential safety precautions and construction procedure is given.

MAGNETISM

(The magnetic properties of solids are included under Solid-State Physics; similarly for Liquid State and Gaseous State)

10755 MAGNETISM OF A SMALL PARTICLE AS REVEALE BY AN ELECTRON BEAM. S.Yamaguchi.
Nuovo Cimento (Italy), Vol. 19, No. 5, 1053-4 (March 1, 1961).

The variation of saturation magnetic induction within and on t surface of small particles of nickel were measured by observing the deflection of an electron beam incident on the particles. S.A.Ah

10756 DEVICE FOR THE RAPID MEASUREMENT OF MAGNETIC ANISOTROPY AT ELEVATED TEMPERATURES. H.Zijlstra.
Rev. sci. Instrum. (USA), Vol. 32, No. 6, 634-8 (June, 1961).

Consists of a self-exciting torsion pendulum containing the magnetic sample, which is suspended in a magnetic field in a furnace. The resonance frequency of the pendulum, which depends on the anisotropy energy in a known way, lies between 10 and 100 c so that the time required for a measurement is shorter than in other methods. The instrument is therefore capable of following a rapidly changing anisotropy, e.g., during the magnetic annealing of the sample. The measurement of the anisotropy of a single crystal of Ticonal G magnet steel during cooling from 900° to 400° C in a magnetic field is described as an example.

10757 ELECTROMAGNETIC SERVO-BALANCE EMPLOYING A DIFFERENTIAL TRANSFORMER. R.A.Butera, R.S.Craig and L.V.Cherry.
Rev. sci. Instrum. (USA), Vol. 32, No. 6, 708-11 (June, 1961).

A servo-balance designed for use in susceptibility measureme is described. A differential transformer is used as the sensing element, and the position of the beam is indicated visually by a me with a zero-centred scale. A switching arrangement allows the servo circuit to be disconnected from the balance and a circuit for manual control of the balancing current substituted.

10758 DEVELOPMENT OF AN ELECTRON OPTICAL METHOD OF MAKING MAGNETIC MEASUREMENTS. I. EXPERIMENTAL ARRANGEMENT AND MEASUREMENTS. H.Murrmann and C.Schwink.
Z. angew. Phys. (Germany), Vol. 13, No. 4, 189-91 (April, 1961). In German.

An electron beam is focused by an electron lens so as to thro on to a screen an image of a bronze net placed before the lens. A magnetized object placed behind the back focal plane distorts this regular image, and from measurements of the degree of distortio the distribution of magnetism around the object can be quantitative evaluated. A magnetizing coil with central slit is used for varyin the magnetization of the object. Details are given of the distribu-tion of magnetization on a simple cylinder and on a cylinder with a slit. V.E.Cossle

10759 DEVELOPMENT OF AN ELECTRON OPTICAL METHOD OF MAKING MAGNETIC MEASUREMENTS. II. THEORETICAL CONSIDERATIONS. C.Schwink and H.Murrmann.
Z. angew. Phys. (Germany), Vol. 13, No. 4, 192-3 (April, 1961). In German.

Theoretical discussion of the method described in the preceding abstract. It is shown that the maximum induction in a split cylinder can be obtained from measurement of the deflection of an electron beam as it passes through the slit. A more accurate method is also described, based on measurements at three points. The magnitude of the return field can also be found. V.E.Cossle

10760 SYSTEM FOR THE PRECISION MEASUREMENT OF LONG-TIME CHANGE OF AN INHOMOGENEOUS MAGNETIC FIELD. W.L.Zingery.
Rev. sci. Instrum. (USA), Vol. 32, No. 6, 706-8 (June, 1961).

The long-time stability is measured with a precision of 3×1 The system is instrumented for short-time dependence on compon stability while referencing on a precision homogeneous field with NMR. An InAs Hall effect sensor is positioned in the gap of a permanent magnet assembly. The Hall voltage is balanced by a low voltage reference source. Without changing the reference voltage the Hall probe is placed in the field of a 6 in. electromagn

ose field is varied to again obtain null, then is measured with an IR gaussmeter. The time requirement on component stability about one minute. The Hall probe is temperature controlled to .01° F.

10761 DESIGN AND CONSTRUCTION OF A SYSTEM OF PULSED MAGNETS.
L.Kuskowski, T.B.Novey and S.D.Warshaw.
Rev. sci. Instrum. (USA), Vol. 32, No. 6, 674-82 (June, 1961).
A system of two pulsed iron-free magnets, designed for an periment in high-energy physics,is described. One of these is small solenoid, with a working volume of about 35 cm^3, pulsed 200 kG; the other is a large magnet with a volume of about 6 litre, lsed at a nominal 15 kG. Construction details, working lifetimes, d details of switch gear are discussed.

10762 SIMPLE LABORATORY ELECTROMAGNETS USING ALUMINUM FOIL MAGNETIZING COILS. S.A.Ahern.
Rev. sci. Instrum. (USA), Vol. 32, No. 7, 814-16 (July, 1961).
The construction of iron-cored electromagnets using aluminium il magnetizing coils is described. A satisfactory procedure for aking the coils is discussed in detail. Performance data for a nall closed-yoke magnet are presented, and the advantages of a ystem of this kind considered.

HYDROMAGNET: A SELF-GENERATING LIQUID ONDUCTOR ELECTROMAGNET. See Abstr. 10770

10763 MINIATURE COILS FOR HIGH MAGNETIC FIELD RESEARCH. R.W.De Blois.
Rev. sci. Instrum. (USA), Vol. 32, No. 7, 816-18 (July, 1961).
Pulsed magnetic fields greater than 100 kOe and of micro-second duration are reported here to be readily producible in millimetre-diameter coils supplied by energy storage units of only several joules capacity. Demonstrative experiments are described which show the magnetic-state transitions of a 20 μg specimen of InAs near 90 kOe, the shift in transition temperature when the specimen and coil are subjected to hydrostatic pressures up to 50 atm, and the reversal of magnetization of a 0.5 μg iron cube from which all reverse nuclei were driven presumably.

TWO-PHASE PERMALLOY FOR HIGH-SPEED SWITCHING. See Abstr. 10166

ELECTROMAGNETISM MAGNETOHYDRODYNAMICS

10764 PERTURBATION THEORY OF THE ELECTRO-MAGNETIC FIELDS IN ANISOTROPIC INHOMOGENE-OUS MEDIA. Y.Hayashi.
Proc. Japan. Acad., Vol. 36, No. 9, 547-9 (Nov., 1960).
Rigorous development of the perturbation theory under the assumption that the deviations from isotropicity and from homogeneity are not large. The deviation of frequency of forced oscillations is derived and the absence of plane waves in such a medium is noted. J.K.Skwirzynski

10765 ON THE VALUES OF THE DIELECTRIC PERMITTIVITY AND THE MAGNETIC PERMEABILITY IN VACUO ACCORDING TO THE EINSTEIN—SCHWARZSCHILD TRANS-FORMATION U.Tiberio.
Ricerca Sci. (Italy), Vol. 30, No. 3, 421-7 (March, 1960). In Italian.
The propagation of light in a Schwarzschild field is interpreted as propagation in a non-uniform medium. Dimensional arguments are introduced to suggest that radiation resistance $\rho = (\mu/\epsilon)^{1/2}$ can be taken to be $\rho_0(c/c_0)^{3/2}$. It is concluded that the dielectric and magnetic coefficients in vacuo can be expressed as $\epsilon = \epsilon_0(c_0/c)^{5/2}$ and $\mu = \mu_0(c/c_0)^{1/2}$, and hence in terms of the potential of the gravitational field. R.A.Newing

10766 ON THE ELECTROMAGNETIC CHARACTERISTICS OF SPACE IN NUCLEAR AND ATOMIC FIELDS.
U.Tiberio.
Ricerca Sci. (Italy), Vol. 30, No. 4, 553-60 (April, 1960). In Italian.
See preceding abstract.

SMALL SIGNAL IMPEDANCE OF A SOLID CORE INDUCTANCE. See Abstr. 10648

10767 REPULSION OF A CHARGED PARTICLE FROM REGIONS WHERE THE MAGNETIC FIELD IS STRONG.
O.B.Firsov.
"Plasma physics", Vol. III (see Abstr. 5439 of 1961), p. 312-20.
A theoretical discussion of the trapping of a single particle in magnetic mirror geometry, assuming only small departures from adiabatic motion. The total path length of a particle in the mirror trap before substantial alteration to the adiabatic invariant, is estimated (on the basis of a random walk addition of corrections) to be of the order $a/[y\,(d/dx)\log\omega]^6$, where a is approximately distance between the mirrors, y is the radius of gyration, ω is the cyclotron frequency, and x is the coordinate in the axial direction. R.S.Pease

10768 INFLUENCE OF COULOMB INTERACTIONS ON THE CYCLOTRON RADIATION OF ELECTRONS MOVING ON A SINGLE ORBIT. R.Gajewski and J.L.Hirshfield.
Phys. of Fluids (USA), Vol. 4, No. 6, 736-9 (June, 1961).
The incoherent cyclotron radiation at the n-th harmonic of the cyclotron frequency from N electrons moving on a single orbit is shown to be reduced by at least a factor $\pi^2n^2N^{-\rho}$ as a result of the nearest-neighbour Coulomb interactions ($\rho \geq 1$), whenever the electron's random thermal energy is less than the Coulomb energy. The conditions under which this theory is valid are compared with those prevailing in the Astron E layer.

10769 STRATA IN ELECTRODYNAMIC VACUUM. D.P.Dishkant.
Ukrayin. fiz. Zh. (USSR), Vol. 4, No. 1, 126 (1959). In Ukrainian.

PLASMA ACCELERATION. THE FOURTH LOCKHEED SYMPOSIUM ON MAGNETOHYDRODYNAMICS. See Abstr. 10694

10770 HYDROMAGNET: A SELF-GENERATING LIQUID CONDUCTOR ELECTROMAGNET.
H.H.Kolm and O.K.Mawardi.
J. appl. Phys. (USA), Vol. 32, No. 7, 1296-1304 (July, 1961).
A novel liquid electromagnet is investigated in which the exciting current is generated within the solenoid by forcing the liquid conductor radially inward through the space between two coaxial cylinders placed in an axial magnetic field. The tangential current thus generated within the flowing conductor adds to the initial applied field so that the device behaves like a self-excited, short-circuited homopolar generator. It is shown theoretically that for low values of the magnetic Reynolds number, the amplification of the magnetic field is a quadratic function of this number and that the total dissipation depends on the square of the amplification and on the cube of the hydrodynamic Reynolds number. The experimental findings are in reasonable agreement with the theory.

10771 SELF-SIMILAR SOLUTIONS OF THE EQUATION OF A LAMINAR BOUNDARY LAYER IN MAGNETO-HYDRODYNAMICS. N.I.Pol'skii and I.T.Shvets.
Dokl. Akad. Nauk SSSR, Vol. 136, No. 5, 1051-4 (Feb. 11, 1961). In Russian.
For abstract, see Abstr. 7129 of 1961. [English translation in: Soviet Physics—Doklady (USA), Vol. 6, No. 2, 121-4 (Aug., 1961)].

10772 JETS OF A PERFECTLY CONDUCTING INVISCID GAS IN THE PRESENCE OF A MAGNETIC FIELD PARALLEL TO THE STREAM. S.Morioka.
J. Phys. Soc. Japan, Vol. 15, No. 8, 1516-22 (Aug. 1, 1960).
The two-dimensional and the axially symmetrical jets of a perfectly conducting inviscid gas in the presence of a magnetic field parallel to the stream are investigated on the basis of the linearized theory, when the jets are governed by the supersonic hyperbolic equation. To this approximation, the fundamental equations and the boundary conditions are found to agree in their forms with those in the ordinary gasdynamic case, except for some parameters. Therefore, it is possible to obtain the solutions at once by making suitable substitution of the parameters in the well-known solutions for the gasdynamic case. However, when the surrounding flow is governed by the subsonic hyperbolic equation, the circumstance is somewhat different from the gasdynamic case because disturbances in the surrounding flow propagate along the upstream characteristics. The structure of such a jet in the two-dimensional case is re-examined from the view point of reflection and refraction of a weak plane shock wave incident upon an interface between two streams.

10773 WALL-EFFECT UPON TWO-DIMENSIONAL STOKES FLOW OF AN ELECTRICALLY CONDUCTING LIQUID IN A UNIFORM MAGNETIC FIELD. Y.Takaisi.
J. Phys. Soc. Japan, Vol. 15, No. 10, 1876-85 (Oct., 1960).

Deals with the steady slow motion of a circular cylinder in a semi-infinite viscous and electrically conducting liquid parallel to its bounding plane wall in the presence of a uniform magnetic field, using Stokes approximation. Detailed calculation is carried out for the flow produced by the cylinder in two cases; one in a parallel magnetic field and the other in a transverse magnetic field. The expansion formulae for the drag per unit span of the cylinder are obtained in terms of the Hartmann number in each case.

10774 PROPAGATION OF SHOCK WAVES IN INHOMOGENEOUS GASES. II. HYDROMAGNETIC SHOCK. Y.Ôno, S.Sakashita and H.Yamazaki.
Progr. theor. Phys. (Japan), Vol. 24, No. 1, 155-60 (July, 1960).

For Pt I, see Abstr. 2780 of 1961. Using the previous method, the propagation of a hydromagnetic shock wave in inhomogeneous magnetic field is considered. The existence of magnetic field has the effect of restraining the growth of shock strength. When the magnetic pressure is large compared with gas pressure, even the diminution of shock strength can occur. As an application, the propagation of shock wave in the solar chromosphere is discussed.

10775 FLOW OVER A WAVY WALL IN MAGNETO-GAS-DYNAMICS. I. EQUILIBRIUM FLOW. O.P.Bhutani.
Progr. theor. Phys. (Japan), Vol. 24, No. 4, 721-33 (Oct., 1960).

The hydromagnetic plane steady flow of an infinitely conducting gas over a thin infinite wave-shaped wall is discussed under the condition that the directions of the flow velocity and magnetic field are in the same plane. When the external magnetic field is parallel to the undisturbed stream, the flow is shown to be current-free and irrotational except for some surface currents. For the case of external magnetic field perpendicular to the undisturbed stream, the hydromagnetic effects consist of the waves of electric currents and vorticity extending from the body. The drag is determined both for subsonic and supersonic cases.

10776 EFFECT OF A MAGNETIC FIELD ON THE FLOW OF A CONDUCTING FLUID THROUGH AN ORIFICE. H.Hasimoto.
Phys. of Fluids (USA), Vol. 4, No. 1, 161-2 (Jan., 1961).

Motion of an incompressible viscous conducting fluid through an orifice is considered in the presence of a uniform magnetic field perpendicular to the orifice. An expression is derived for the flow rate through the orifice and it is shown that the flow rate decreases with increase of magnetic field or conductivity of the fluid.
M.Hasan

10777 ON A CLASS OF MOTIONS IN MAGNETOHYDRODYNAMICS. V.N.Zhigulev.
Priklad. Mat. i Mekh. (USSR), Vol. 22, No. 3, 389-90 (1958). In Russian.

Treats the dynamics of a perfectly conducting inviscid compressible fluid when the magnetic field and velocity vectors are constant along the lines of force. For this case the magnetic field does not greatly alter the character of the basic equations of hydrodynamics. Generalized forms of the circulation theorem, Bernoulli's theorem, and Lagrange's equation are derived. O.Penrose

10778 ON THE UNIQUENESS OF QUASIHYPERBOLIC MAGNETOHYDRODYNAMIC FLOWS. M.N.Kogan.
Priklad Mat. i Mekh. (USSR), Vol. 24, 370-1 (1960). In Russian. English translation in: J. Appl. Math. Mech., Vol. 24, 530-3.

The case under consideration is steady, hyperbolic, subsonic, magnetogasdynamic flow, which occurs with "aligned fields" if the conductivity is infinite. To show that the wave pattern set up by a solid body in such a flow is made up to forward-running waves, the author considers weak shock waves originating at the body and attenuating outward. He shows that the waves producing such attenuation must be members of the same family as the (weak) shock. Drawing upon his earlier investigations of shock waves [Ibid., Vol. 23, No. 3, 70-80 and 557-563 (1959)]; he shows that the aft-running are impossible. (American Rocket Society Journal, Vol. 29, 397-406). Mathematical Reviews (W.R.Sears)

10779 MAGNETO-FLUID DYNAMIC SHOCK WAVES. R.Lüst.
Rev. mod. Phys. (USA), Vol. 32, No. 4, 706-9 (Oct., 1960).

Magneto-fluid Dynamics Symposium (see Abstr. 4700 of 1961). A review article with about 30 references. O.Penrose

10780 SOME MAGNETO-FLUID DYNAMIC EFFECTS IN A FINITELY CONDUCTING MEDIUM. V.N.Zhigulev.
Rev. mod. Phys. (USA), Vol. 32, No. 4, 828-30 (Oct., 1960).

Magneto-fluid Dynamics Symposium (see Abstr. 4700 of 1961). A brief review (10 references) of Russian work (mostly the author) on magnetic boundary layers, including work (Abstr. 15116 of 1960) showing that a diverging axially symmetric discharge ejects gas. These "boundary layers" arise when the magnetic Reynolds numbe is very large. The author disguishes two kinds of layer, one with the magnetic field nearly parallel to the flow and the other with th current nearly parallel to the flow. He also discusses "pressing-off" in which the fluid loses contact with the boundary wall.
O.Penro

10781 UNIQUENESS OF THE SOLUTION OF MAGNETO-HYDRODYNAMIC BOUNDARY VALUE PROBLEMS. C.Hargitai and J.Szabó.
Z. Naturforsch. (Germany), Vol. 16a, No. 1, 92-4 (Jan., 1961). In German.

The uniqueness was proved using the method similar to the on employed by Dolidse [Dokl. Akad. Nauk SSSR, 46, 437 (1954)] for establishing the uniqueness of the solution of the Navier—Stoke's equation of ordinary hydrodynamics. M.Has

ELECTROMAGNETIC WAVES AND OSCILLATIONS

(See also Plasma Oscillations)

10782 ON THE THEORY OF AMPLITUDE DISTRIBUTION OF IMPULSIVE RANDOM NOISE. K.Furutsu and T.Ishida
J. appl. Phys. (USA), Vol. 32, No. 7, 1206-21 (July, 1961).

Two phenomenological models are considered by which impulsive random noises can be described: (a) Poisson noise, consistin of the superposition of independent, randomly occurring elementar impulses. Much electronic noise belongs to this type and the familiar physical examples are precipitation noise, ignition noise, and solar "static." (b) Poisson—Poisson noise, consisting of the superposition of independent, randomly occurring Poisson noise, each type of Poisson noise forming a wave packet of some duratio Atmospheric noise is a representative example of the latter type. The attempt at first is made to deduce the general amplitude distribution for each model; then, because the noise sources in nature are spatially distributed and noise strength decreases with distance so that the amplitude of the received noise sometimes depends seriously on this spatial distribution of noise sources, the amplitude probability distributions are considered according to the two typical cases of the discrete and continuous spatial distributio and are compared with those of actual atmospherics. Moments of even order and correlation functions are also calculated for each model. Finally, the dependence of the assumptions used on amplitude probability distribution are discussed. The distributions obtained are, in some cases, found to be independent of the adopted models and some of the used assumptions in a wide range of noise amplitude.

10783 EMISSION OF RADIO-FREQUENCY WAVES FROM PLASMAS. G.Bekefi and S.C.Brown.
Amer. J. Phys., Vol. 29, No. 7, 404-28 (July, 1961).

Observations of the radio-frequency emission from extra-terrestrial plasmas and plasmas produced in the laboratory are described, and various attempts at interpretation of the results ar reviewed. Estimates are made of the probable loss of radiant energy from plasmas in proposed thermonuclear reactors.

10784 PARAMETRIC COUPLING BETWEEN THE TRANSVERSE WAVES ON O- AND M-TYPE BEAMS. J.W.Klüver.
J. appl. Phys. (USA), Vol. 32, No. 6, 1111-14 (June, 1961).

The coupling between transverse waves on a "no-space-charg beam model via an r.f. pump field is investigated. It is found that the pump field should be two-dimensional in order to couple only two waves together. For high-frequency pumping only waves of same polarization can couple together, for low-frequency pumping only two waves of opposite polarization can couple together. For high-frequency pumping no "spilling" of higher-order noise frequencies will occur. For low-frequency pumping no "spilling" will occur if the pump field is purely circularly polarized. Except

r cyclotron—cyclotron wave coupling the pump wave will always in synchronism with a beam wave and thus interact actively passively with the beam. The effect of this coupling is vestigated.

10785 ENERGY INTERCHANGE BETWEEN CYCLOTRON AND SYNCHRONOUS WAVES IN QUADRUPOLAR PUMP ELDS. E.I.Gordon and A.Ashkin.
appl. Phys. (USA), Vol. 32, No. 6, 1137-44 (June, 1961).

Passive coupling of the electron cyclotron and synchronous aves in quadrupolar pump fields is examined. It is shown that nusoidal energy exchange occurs when the quadrupole field is mped so that the effective or Doppler-shifted pump frequency as bserved by the drifting beam equals the electron cyclotron equency. One fast and one slow wave are coupled when the pump equency is greater than either of the beam wave frequencies, hile two fast or two slow waves are coupled when the pump freq- ency is less than at least one of the beam wave frequencies. xperimental results confirming these predictions are presented nd possible applications are discussed. In addition, it is shown at active coupling of two synchronous waves occurs when the ffective pump frequency is zero.

10786 TRANSDUCTION OF NOISE. THEORY OF A GENERALIZED TRAVELING-WAVE COUPLER. .C.Pease.
. appl. Phys. (USA), Vol. 32, No. 6, 1145-51 (June, 1961).

The response of an appropriate system to a noise input is tudied. The systems studied are "generalized lossless networks" nd may include, for example, electron beams and parametrically umped components. The noise may be introduced through several orts in an uncorrelated or correlated way. The problem is onveniently handled by the matrix analogue of an eigenvector nalysis. The noise input is represented as a matrix of which the liagonal elements are the self-power density spectra, and the off- liagonal elements the cross-power density spectra. This matrix s resolved into "eigenmatrices" which are then recombined at he output in accordance with the "2-index eigenvalues". The noise nvariants found by Haus (S and π) are appropriate to a system with wo degrees of freedom. For a system with n degrees of freedom, here are at least n invariants of the noise, i.e., components of the oise that are unchanged by the system. The theory is finally pplied to a generalized coupler, in which a single circuit mode is oupled to a degenerate multiplicity of beam modes, such as would ccur in a hollow beam. It is shown that a "Kompfner-null" con- dition exists. The physical significance of this condition is studied and its effect on beam noise determined.

RADIATION BY A LARGE-AMPLITUDE PLASMA OSCILLATION. See Abstr. 10726

10787 STUDY OF A CROSS-RELAXATION MASER. Y.Ayant, R.Buisson, D.Descamps and M.Soutif.
C. R. Acad. Sci. (France), Vol. 252, No. 14, 2081-3 (April 5, 1961). In French.

The conditions which caninterfere with the realisation of population inversion in multi-level quantum-mechanical amplifiers are analysed. It is shown that in certain cases these conditions can lead to an improvement in maser performance. Consideration of the transfer of energy between pairs of levels in an electronic spin system in which the energy gaps bear a simple relationship to each other is relevant to the case of an S-band ruby maser operating at low angles ($0^0 < \theta < 12^0$), and pumped at X-band, in which both effects may be observed by variation of θ. S.A.Ahern

10788 OPTICALLY EFFICIENT RUBY LASER PUMP. P.A.Miles and H.E.Edgerton.
J. appl. Phys. (USA), Vol. 32, No. 4, 740-1 (April, 1961).

A typical ruby laser requires 6 J to equalize populations in the pumping levels. This could be achieved with a 120 J flash tube. In practice previously 2000 J has been needed. By aligning the laser with one or more Xe flash tubes and using reflecting shields, a threshold coherent pulse was obtained with 200-320 J of pump energy. D.Walsh

10789 THEORY OF QUANTUM OSCILLATORS IN A MULTIMODE CAVITY. W.G.Wagner and G.Birnbaum.
J. appl. Phys. (USA), Vol. 32, No. 7, 1185-94 (July, 1961).

The spectrum of power radiated by a solid-state optical maser in a steady-state operation is obtained by considering each atomic system to be a source of a randomly fluctuating dipole moment which drives every mode of the cavity. The nonlinear behaviour of the collection of atomic systems is treated in such a way that a detailed examination of the distribution of power in the various modes is possible. A number of examples are considered which show how critically dependent on the relative loss rates of the various modes are the characteristics of the output from a multi-mode oscillator. An interesting result of this calculation is the appearance, in some cases, of an abrupt transition as the pumping power is increased. Above this point a large fraction of energy goes into the mode which is resonant with the atomic transition and which has the lowest loss rate. Another case is studied which does not have this feature, but which could be useful in analysing the behaviour of solid-state optical masers which have substantial scattering due to crystal imperfections.

10790 PARAMAGNETIC MASER OSCILLATOR ANALYSIS. S.Wang and J.R.Singer.
J. appl. Phys. (USA), Vol. 32, No. 7, 1371-6 (July, 1961).

A physical and mathematical description of maser oscillation is given with particular emphasis upon explaining the structure of the output line shape. Several approaches to the problem are taken. A qualitative description of the motion of the spin vector is followed by a derivation of the equations pertinent to the interaction of a tuned circuit (microwave cavity) and precessing spins. The resultant equation is nonlinear. Approximate solutions are given and these are plotted as output amplitude versus time. In addition, the equations are solved with numerical solutions for specific experimental conditions by means of a digital computer. The numerical results are compared with experimental data. The field-swept oscillator line shapes are explained by the analysis, and the steady state oscillator is described as well.

10791 INFLUENCE OF FLUCTUATIONS IN THE NUMBER OF MOLECULES ON THE FREQUENCY OF A MOLECULAR-BEAM MASER OSCILLATOR. T.C.Wang.
J. Phys. Radium (France), Vol. 21, No. 4, 261-3 (April, 1960). In French.

This is studied by an extension of the discussion given in Abstr. 5768 of 1956. J.Hawgood

INTERSTELLAR AND INTERPLANETARY COMMUNICATION BY OPTICAL MASERS. See Abstr. 10367

PLASMA AS A MICROWAVE AMPLIFIER. See Abstr. 10716

10792 PROPAGATION IN PERIODIC ELECTRON BEAMS. W.M.Mueller.
J. appl. Phys. (USA), Vol. 32, No. 7, 1349-60 (July, 1961).

A small-signal analysis of smooth electron beams with periodic variations in their d.c. parameters reveals the existence of infinite sets of space harmonics of the fast and slow space-charge waves. For a finite beam coupling between the space-charge waves and field waves exists at an infinite number of frequencies. The periodicity of a beam has a very small effect on the space-charge wave propagation constants. Velocity-jump, rippled-stream, and rippled-wall amplification are shown to result from coupling between fast and slow space-charge waves of adjacent harmonics. The periodicity of an electron beam will have negligible effect on most conventional travelling-wave devices. Although the frequency dependence of the amplitudes of the beam harmonics may introduce difficulties in some devices, this dependency may also be made use of in a variety of ways. Beam harmonics make millimetre-wave interactions possible in smooth circuits, but practical devices at these frequencies will probably be limited to those employing positional periodicity of the beam.

10793 THEORY OF THE DIPOLE ANTENNA AND THE TWO-WIRE TRANSMISSION LINE. Tai Tsun Wu.
J. math. Phys. (USA), Vol. 2, No. 4, 550-74 (July-Aug., 1961).

The properties of the dipole are studied by an approximate procedure that makes use of the Wiener–Hopf integral equation In particular, the input admittance and the radiation pattern are found. The present results thus supplement the existing theories, which are concerned mostly with short dipoles. The same procedure is then applied to several related problems. First, the back-scattering cross-section of a dipole aerial is found approximately for normal incidence. Secondly, the two-wire transmission line is studied in detail by considering it to be two coupled dipole aerials. The capacitive end correction for an open end is evaluated, and the radiated power and the radiation resistance are found for a resonant section of transmission line with both ends open. Finally, the dielectric-coated aerial is considered briefly.

ROLE OF END-FIRE AND BROADSIDE RADIATION IN REFRACTION, DISPERSION, AND SUPERGAIN. See Abstr. 10602

MULTIPLE SCATTERING OF ELECTROMAGNETIC WAVES. See Abstr. 10571

Radiofrequency Spectroscopy Techniques

10794 APPARATUS DRAWINGS PROJECT. REPORT NUMBER 18. NUCLEAR MAGNETIC RESONANCE ABSORPTION APPARATUS. R.G.Marcley.
Amer. J. Phys., Vol. 29, No. 7, 451-8 (July, 1961).

An apparatus utilizing a one-tube oscillating detector is described. It can be used to determine the gyromagnetic ratio γ of nuclei, from which their magnetic moment μ can be computed. If operated in conjunction with an Omegatron in the same magnetic field, it permits the determination of μ of the proton directly from two frequency measurements only. Measurements on protons are made with samples of water and common oils, data on fluorine is obtained from the plastic, Teflon. The apparatus is also useful for accurate measurements of magnetic fields. The determination of γ and H can be made with a precision of about ±0.02%. The accessory equipment required consists of a magnet producing a field of several kG homogeneous to at least 1 part in 10^3; a frequency meter; a communications receiver; and a cathode-ray oscilloscope.

10795 APPARATUS DRAWINGS PROJECT. REPORT NUMBER 19. APPARATUS FOR ELECTRON PARAMAGNETIC RESONANCE AT LOW FIELDS. R.G.Marcley.
Amer. J. Phys., Vol. 29, No. 8, 492-7 (Aug., 1961).

A simple apparatus for investigating e.s.r. in a magnetic field of 100 G is described. A one-tube oscillating detector with a shorted, quarter-wave coaxial line resonant circuit, operating at 315 Mc/s is used. The 100 G field is obtained from small Helmholtz coils. The auxiliary electronic equipment required to operate this apparatus is conventional.

10796 THE RAPID TRACING OF RADIOFREQUENCY SPECTRA OF DIELECTRICS FROM 1 TO 10 000 Mc/s. A.Lebrun, E.Constant, M.Moriamez, R.Liebaert and A.Risbourg.
Arch. Sci. (Switzerland), Vol. 13, No. Fasc. Spec., 104-7 (1960). In French.

9th Colloque Ampère Paper (see Abstr. 4734 of 1961). A review of equipment for improved rapidity of tracing radiofrequency spectra of dielectric liquids and solids. A relative accuracy of 1% or better can also be attained. Between 100 and 1500 Mc/s an adaptation of the admittance meter type GR1602B is used. Coaxial cell arrangements for wide frequency ranges, and variations depending on the dielectric loss of the material are outlined.
J.Sheridan

10797 POSSIBILITIES OF IMPROVING METHODS IN QUADRUPOLE RESONANCE.
P.Kesselring, F.Herlach, D.Itschner and H.R.Winteler.
Arch. Sci. (Switzerland), Vol. 13, No. Fasc. Spec., 645-8 (1960). In French.

9th Colloque Ampère Paper (see Abstr. 4734 of 1961). A preliminary report on work on detection of very weak quadrupole resonances. The mechanism of super-regenerative receivers is discussed in relation to obtaining supplementary information from the signals. Development of sensitive detectors, with low distortion, is also briefly mentioned.
J.Sheridan

10798 NUCLEAR TRANSFER EFFECTS IN NUCLEAR MAGNETIC RESONANCE PULSE EXPERIMENTS.
D.E.Woessner.
J. chem. Phys. (USA), Vol. 35, No. 1, 41-8 (July, 1961).

The Bloch equations for the nuclear magnetic resonance of a single nuclear species which is transferred between state environments having different relaxation times (T_1 or T_2) and different resonance frequencies are solved for r.f. pulse experiments. Expressions are obtained for the free precession signals in two-pulse experiments. A theoretical study of the signal envelopes is made for several specific instances. In particular, the effect of t frequency difference between the two states on transverse (T_2) relaxation is investigated; the predicted effect is large in some cases. The longitudinal (T_1) relaxation is independent of the frequency separation. A reduction of phase dispersion by the sec pulse which is similar to that in molecular diffusion is also predicted.

10799 PARAMAGNETIC RESONANCE DETECTED BY MEANS OF A PARAMETRICALLY EXCITED CIRCUIT. Yu.S.Konstantivov.
Pribory i Tekh. Eksper. (USSR), 1959, No. 6, 134 (Nov.-Dec., 195 In Russian.

Nuclear magnetic resonance was detected in acetic acid by means of a parametrically excited circuit containing a germaniu diode, the capacitance of which depends on the applied voltage. [English translation in: Instrum. exper. Tech. (USA), No. 6, 990 (Nov.-Dec., 1959; publ. Sept., 1960)]. S.A.Ahe

10800 FREQUENCY MODULATED, LOW LEVEL, RF SPECTROMETER FOR NUCLEAR RESONANCE.
C.H.Dutcher, Jr and T.A.Scott.
Rev. sci. Instrum. (USA), Vol. 32, No. 4, 457-8 (April, 1961).

Directions for modifying a Robinson type oscillator (Abstr. 3867 of 1960) for frequency modulation, using a silicon voltage variable capacitor.
C.J.Ul

10801 APPARATUS FOR E.P.R. STUDIES IN THE TEMPER TURE INTERVAL 25° TO 500°C.
C.P.Poole, Jr and D.E.O'Reilly.
Rev. sci. Instrum. (USA), Vol. 32, No. 4, 460 (April, 1961).

Description of a simple oven for an X-band TE_{012} cavity. D.C power is used to prevent interference from vibrations of the heating coils.
C.J.U

10802 VARIABLE COUPLING REFLECTION CAVITY FOR MICROWAVE SPECTROSCOPY. J.P.Gordon.
Rev. sci. Instrum. (USA), Vol. 32, No. 6, 658-61 (June, 1961).

The variable coupling scheme achieves slightly greater sensiti than does the usual microwave bridge circuit. It can single out either the absorption or dispersion component of a resonance sig without using bridge techniques. It is considerably less sensitive to microphonic noise than is the bridge. It is recommended for u in reflection-type cavity spectrometers.

10803 MICROWAVE SUPERHETERODYNE INDUCTION SPECTROMETER.
D.T.Teaney, M.P.Klein and A.M.Portis.
Rev. sci. Instrum. (USA), Vol. 32, No. 6, 721-9 (June, 1961).

The sensitivity of the conventional bridge absorption specto-meter is found to decrease rapidly below the theoretical limit se by the noise figure of the receiver when klystron power is increa above about 10 mW. This decrease is shown to arise from the extreme frequency dependence of the bridge balance. The bimod cavity induction spectrometer, which has a highly stable frequenc independent balance, shows no departure from the theoretical lim Flicker noise is found to be produced by the i.f. current in the mi diodes, but it may be greatly reduced by the use of high i.f. gain. The use of a balanced homodyne detector in place of the conventi second detector is found to reduce the over-all noise figure of th receiver from 13 to 9 dB by suppression of carrier noise. The performance of the bridge spectrometer is greatly improved by t homodyne detector which discriminates against frequency noise th enters when the bridge drifts away from balance.

NUCLEAR PHYSICS

APPARATUS
PARTICLE DETECTORS

(Counting circuits are included under Electrical Measurements and Circuits)

10804 ON THE THEORY OF CORONA DISCHARGE IN NUCLEAR RADIATION COUNTERS.
.Ya.Savel'ev and Yu.O.Noskov.
ribory i Tekh. Eksper. (USSR), 1961, No. 1, 47-50 (Jan.-Feb.).
i Russian.

The effect of external circuit parameters on the behaviour of ie discharge was investigated theoretically and experimentally. ood agreement between the theory and experiment is reported. S.Chomet

10805 BORON TRIFLUORIDE CHAMBER WITH GAMMA-BACKGROUND COMPENSATION.
A.B.Dmitriev and M.G.Vorob'ev.
Pribory i Tekh. Eksper. (USSR), 1961, No. 1, 55-7 (Jan.-Feb).
In Russian.

Constructional details of the chamber are given. The sensitivitv o thermal neutrons is 5×10^{-13} A neutron^{-1} cm^{-2} sec^{-1}. The compensating part is filled with Kr at about 6.5 atm. The γ-ray sensitivity can be reduced to 4×10^{-13} A r^{-1} hr^{-1}. S.Chomet

10806 A STUDY OF PULSE HEIGHT DISTRIBUTION OF BORON TRIFLUORIDE PROPORTIONAL COUNTERS.
M.Yamane.
J. Phys. Soc. Japan, Vol. 15, No. 10, 1732-6 (Oct., 1960).

The pulse height distribution of the counter under overall irradiation by slow neutrons was treated allowing for the wall effect of the counter. The energy spectra, $R(\epsilon')$, is given under assumption of a Gaussian resolution function by

$$R(\epsilon') \cong \frac{s}{2R\bar{E}_0}\int_0^{E_0} \frac{1}{\sqrt{2\pi}\sigma} \exp\left\{-\frac{(\epsilon'-\epsilon)^2}{2\alpha^2}\right\} d\epsilon +$$

$$+ \left(1 - \frac{S}{2R}\right)\frac{1}{\sqrt{2\pi}\sigma} \exp\left\{-\frac{(\epsilon' - E_0)^2}{2\sigma^2}\right\},$$

where s and E_0 are the whole range and initial energy of the alpha particles respectively, and R is the radius of the counter. Agreement between the theoretical and the experimental distribution was discussed for appropriate filling pressures.

10807 COMPLEMENTARY NOTE ON SCINTILLATION CHAMBERS. J.Duflo.
J. Phys. Radium (France), Vol. 21, Suppl. No. 3, 70A (March, 1960).
In French.

Describes how the performance of the scintillation chamber presented in a previous paper (Abstr. 7182 of 1961) can be greatly improved by the use of a special type of amplifier. C.F.Barnaby

10808 THIN-WINDOW SCINTILLATION ALPHA-DETECTOR.
A.V.Elpidinskii and I.N.Fetisov.
Pribory i Tekh. Eksper. (USSR), 1961, No. 1, 57-60 (Jan.-Feb.).
In Russian.

The phosphor is compressed ZnS on a perspex base. The phosphor is covered by an Al—polystyrene—Al coating and is mounted directly on a photomultiplier. The efficiency for alpha-sources with low self-absorption is 73-87% for 4.5-5.3 MeV α-rays. The detectors (80 mm in diameter) were developed for use with portable instruments. The window thickness is equivalent to 6mm of air and the minimum detectable range in the phosphor is equivalent to 2 mm of air. S.Chomet

10809 LARGE VOLUME PLASTIC SCINTILLATORS.
M.N.Medvedev, E.N.Matveeva and L.Ya.Zhil'tsova.
Pribory i Tekh. Eksper. (USSR), 1958, No. 3, 45-8 (May-June).
In Russian.

Methods are described for the preparation of polystyrene solution scintillators of 3 l. and larger. The scintillation pulse amplitudes from large plastic scintillators were measured as a function of the position of the point of irradiation by 2.62 MeV γ rays. [English translation in: Instrum. exper. Tech. (USA), No. 3, 367-70 (May-June, 1958; publ. June, 1959)]. J.B.Birks

10810 GAMMA-RAY SPECTRA IN LARGE ORGANIC SCINTILLATORS. P.R.J.Burch.
Proc. Phys. Soc. (GB), Vol. 77, Pt 6, 1125-32 (June, 1961).

For moderately large organic scintillators, a linear relation is found between the position of the γ-ray "Compton peak" and the maximum energy transfer in a first Compton collision. Extrapolation yields a positive intercept on the energy axis as a result of the dependence of the specific light output of scintillators on the linear energy transfer of charged particles. The broadening of the Compton peak on the high-energy side has three components: (a) statistical, (b) intrinsic line broadening arising from multiple interactions of the γ-ray, and (c) geometrical, resulting from the variation of light collection efficiency with the position of the event in the scintillator. The dependence of these three components on γ-ray energy is considered and their approximate magnitudes for two plastic scintillator units are calculated from experimental γ-ray spectra.

10811 GAMMA-RAY ATTENUATION FACTORS FOR ANGULAR CORRELATION AND ANGULAR DISTRIBUTION MEASUREMENTS. D.W.Glasgow, L.W.Coleman and L.Schecter.
Rev. sci. Instrum. (USA), Vol. 32, No. 6, 683-4 (June, 1961).

The angular resolution and azimuthal symmetry of an unshielded NaI scintillation counter was measured for gamma-rays between 0.5 and 2.8 MeV in order to estimate correction factors needed in determining angular correlation functions. The results are in agreement with the corrections calculated by Rose (1953) and extended by Stanford and Rivers (1959), for similar scintillation crystal geometry.

10812 STABILIZED SCINTILLATION COUNTER.
S.A.Scherbatskoy.
Rev. sci. Instrum. (USA), Vol. 32, No. 5, 599-600 (May, 1961).

A technique is described for maintaining overall counter gain stability without using a highly stabilized power supply to run the photomultiplier. Standard light pulses are obtained from either a flashing glow discharge tube or a secondary scintillation crystal combined with an α-particle source. Light pulses from the main crystal are attenuated by a filter so that the standard pulses are much bigger than the spectrum pulses. The pulses are then amplified in the usual way and fed via a rectifier to a control tube, where the difference between the pulse voltage and a standard voltage supply is used to control the photomultiplier voltage. The standard voltage supply does not require a very high degree of regulation since it only affects the overall gain as the first power compared with the eighth or higher power effect of the photomultiplier supply voltage. This feedback control loop also takes care of changes in amplifier gain and photomultiplier tube characteristic due to time, temperature or tube changes. I.Cooke

10813 PULSE SHAPE DISCRIMINATION IN STILBENE SCINTILLATORS. W.Daehnick and R.Sherr.
Rev. sci. Instrum. (USA), Vol. 32, No. 6, 666-70 (June, 1961).

A simple, sensitive discriminator is described, which was designed to permit detection of low energy neutrons in the presence of a very high γ-ray background, and at high counting rates. An improvement relative to discrimination circuits published so far was obtained by incorporating a fast crystal diode switch for the separation of the fast and slow parts of the scintillator de-excitation pulse. This device greatly reduces interference effects of nearly coincident detector pulses and also permits better pulse matching and comparison. The best discrimination was obtained for moderate sensitivity and counting rates, where out of 10^8 detected γ-rays about one was erroneously admitted. A detailed description of the circuit and accessories is given, and results of test runs at a 20 MeV FM cyclotron are presented.

10814 GAS SCINTILLATION DETECTOR FOR THE RECORDING OF FISSION FRAGMENTS. V.F.Gerasimov.
Pribory i Tekh. Eksper. (USSR), 1961, No. 1, 61-4 (Jan.-Feb.).
In Russian.

The working gas is Xe or He. The detector is used to record fission fragments against a background of 3×10^6 α-particles per

sec. The device was used to measure the fission cross-section of Am^{241} for monochromatic neutrons in the energy range 0.004-0.4 eV.
S.Chomet

10815 GAS-FILLED CHERENKOV THRESHOLD COUNTERS FOR ACCELERATOR WORK.
A.N.Belyakov, A.S.Vovenko, A.D.Kirillov, B.A.Kulakov, A.L.Lyubimov, Yu.A.Matulenko and I.A.Savin.
Pribory i Tekh. Eksper. (USSR), 1961, No. 1, 32-5 (Jan.-Feb.). In Russian.

Two types of air-filled variable-pressure Cherenkov counters are described. The counters were used to detect rare particles against a large background of other particles, e.g. μ-mesons in a beam of 300 MeV π-mesons. The particle differentiation is achieved by measuring the response of the counters as a function of pressure.
S.Chomet

10816 DIRECTIONAL HIGH ENERGY GAMMA-RAY COUNTER.
G.G.Fazio and E.M.Hafner.
Rev. sci. Instrum. (USA), Vol. 32, No. 6, 697-702 (June, 1961).

A directional Cherenkov counter was developed for detection of energetic gamma-rays from balloons and satellites. It is sensitive to photons whose directions lie within a 10^0 cone. It is completely insensitive to backward fluxes and almost completely insensitive to charged particles. Several different versions of the system were constructed, and tested in bremsstrahlung beams. The angular resolution was also indirectly confirmed by using the device to count cosmic ray muons at sea level.

STATISTICAL TESTS FOR COUNTING. See Abstr. 11046

Track Visualization

10817 A HIGH-SPEED DOUBLE-ACTION GAS VALVE FOR A BUBBLE CHAMBER.
L.M.Barkov, K.N.Mukhin, A.V.Tel'nov and R.S.Shlyapnikov.
Pribory i Tekh. Eksper. (USSR), 1959, No. 6, 122-3. In Russian.

Describes the construction and action of a high speed double action gas valve used with a 10 l. propane bubble chamber. The valve exhausts 0.5 l. of gas at 50 atm. in $\sim 5 \times 10^{-3}$ sec, fills the same volume to 50 atm in $\sim 30 \times 10^{-3}$ secs. [English translation in: Instrum. exper. Tech. (USA), No. 6, 979-80 (Nov.-Dec., 1959; publ. Sept., 1960)].
R.H.Thomas

10818 A LIQUID-HYDROGEN BUBBLE CHAMBER WITH A DIAMETER OF 25 cm.
M.S.Ainutdinov, S.M.Zombkovskii, S.Ya.Nikitin and Ya.M.Selektor.
Pribory i Tekh. Eksper. (USSR), 1961, No. 1, 35-9 (Jan.-Feb.). In Russian.

The working volume is about 4.9 litres and the chamber is so designed that parts at liquid N and liquid H temperatures can be independently removed. The chamber is operated in a field of 14 000 Oe, produced by a specially designed electromagnet. The chamber requires about 12 litres of liquid H to cool it down from 77^0 to 20^0K. The overall time to cool it from room temperature down to 20^0K is usually about 24 hr. Under dynamic conditions (14 sec cycle) the liquid N consumption is 2-2.5 *l*/sec, the pressure limits are 5.5 and 1.8 atm, and the corresponding temperatures of the chamber and hydrogen bath are 27^0K and 26.5^0K respectively.
S.Chomet

10819 TYPICAL BUBBLE CHAMBER PICTURES PRODUCED BY RELATIVISTIC ELECTRONS UNDER 30 MeV.
G.Harigel, D.Lüers, H.M.Mayer, M.Scheer and K.Schultze.
Z. angew. Phys. (Germany), Vol. 13, No. 5, 217-23 (May, 1961). In German.

Describes a 10 cm heavy liquid bubble chamber designed for operation with a 35 MeV electron synchrotron. The method of operation is described and typical pictures taken with propane and freon shown. Possible experiments are discussed.
R.H.Thomas

10820 DETERMINATION OF THE SIGN OF THE CHARGE OF PARTICLES IN PHOTOGRAPHIC EMULSIONS.
I.M.Gramenitskii, Z.Korbel and L.Rob.
Pribory i Tekh. Eksper. (USSR), 1961, No. 1, 42-4 (Jan. Feb.). In Russian.

A stack of emulsions was exposed to the internal beam of a 9 GeV proton accelerator. The magnetic field during the exposure was 12 k Oe. It was found that it is possible to carry out a statistical determination of the signs of the secondary particles produced in interactions between the primary protons and emulsion nuclei, by measuring their deflection in the magnetic field. Track lengths of 6-10 cm are necessary.
S.Chom

10821 THE DEVELOPMENT OF NUCLEAR EMULSIONS.
L.M.Barkov and D.M.Samoilovich.
Dokl. Akad. Nauk SSSR, Vol. 136, No. 5, 1059-62 (Feb. 11, 1961). In Russian.

For abstract, see Abstr. 7180 of 1961. [English translation in Soviet Physics—Doklady (USA), Vol. 6, No. 2, 143-5 (Aug., 1961)].

10822 AUTOMATIC DEVELOPMENT OF NUCLEAR EMULSIONS. C.A.Bovet and E.Jeannet.
Rev. sci. Instrum. (USA), Vol. 32, No. 7, 819-21 (July, 1961).

An automatic device to develop nuclear plates has been built. The replacement or the dilution of the liquids and the changes and stabilization of the temperatures are controlled by an electronic programme device using a transparent tape and a connection matrix. This system presents the advantage of great flexibility an ensures total reliability. Use is made of temperature development in wet conditions. Tests showed homogeneity and reproducibility within 1%.

10823 REPORT ON SPARK CHAMBER WORK AT NEVIS LABORATORY. L.M.Lederman.
Rev. sci. Instrum. (USA), Vol. 32, No. 5, 523-7 (May, 1961).

Spark Chamber Symposium (see Abstr. 9698 of 1961). Descri spark chamber research at Columbia University. Aspects discuss are: constructional features of the chambers; spark gap coincidence trigger techniques; high-voltage switches; automatic scanning of photographs and microwave spark chambers.
R.H.Thom

10824 REPORT ON SPARK CHAMBER WORK AT PRINCETON. G.K.O'Neill.
Rev. sci. Instrum. (USA), Vol. 32, No. 5, 528-9 (May, 1961).

Spark Chamber Symposium (see Abstr. 9698 of 1961). Describ work on spark chambers intended for accurate momentum determi ation. The operation of small chambers built to check the working of a large 128 gap chamber and a 46 gap neon chamber is describe 1% accuracy on momentum determination for a 1 BeV/c particle at 18 kgauss seems possible.
R.H.Thom

10825 AUTOMATIC SCANNING OF SPARK CHAMBER PHOTOGRAPHS. L.J.Koester, Jr.
Rev. sci. Instrum. (USA), Vol. 32, No. 5, 529-30 (May, 1961).

Spark Chamber Symposium (see Abstr. 9698 of 1961). Discus briefly some of the suggestions made for scanning spark chamber photographs automatically.
R.H.Thom

10826 NOTE ON THE PROBLEM OF AUTOMATIC SCANNIN OF SPARK CHAMBER PHOTOGRAPHS. A.Roberts.
Rev. sci. Instrum. (USA), Vol. 32, No. 5, 531 (May, 1961).

Spark Chamber Symposium (see Abstr. 9698 of 1961). In orde to scan pictures at the event production rate, up to 5 events per se must be scanned.
R.H.Thom

NUCLEAR FIELD THEORY

10827 DOMAINS OF DEFINITION FOR FEYNMAN INTEGRA OVER REAL FEYNMAN PARAMETERS. Tai Tsun W
Phys. Rev. (USA), Vol. 123, No. 2, 678-89 (July 15, 1961).

Given a Feynman diagram, the corresponding integral over re Feynman parameters is meaningful and analytic in a certain domai in the space of the Lorentz invariants formed from the external momenta, each of which is on the mass shell. In the case where all the masses are equal, the intersection of these domains for all proper convergent diagrams is studied. For the cases of four and five external lines, the real intersections are explicitly found; for the case of six, seven, and eight external lines, procedures for finding the real intersections are given. A knowledge of the real intersection makes it possible to construct geometrically a subset of the complex intersection. Generalization to unequal external masses is briefly considered.

10828 THEORY OF MATTER WITH SUPER LIGHT VELOCITY. S.Tanaka.
rogr. theor. Phys. (Japan), Vol. 24, No. 1, 171-200 (July, 1960).

Matter with a super light velocity is treated as one possible odel in the course of looking for the physical concept that will ssentially govern the future theory of elementary particles. irst, it is investigated according to canonical quantization as to hat extent this matter could be reconciled to the usual particle spect of elementary particle. Further, taking into consideration he interaction of this matter with other particles, it is attempted o quantize this matter so as to derive the Lorentz-invariant, but uasi-causal S-matrix and to remove the free state of this matter rom possible physical states.

10829 ABANDONMENT OF THE ASSUMPTION OF THE DISPLACEMENT INVARIANCE AND REPLACEMENT OF THE ASSUMPTION OF FIELD BY THE ASSUMPTION OF PARTICLE. T.Tati.
Progr. theor. Phys. (Japan), Vol. 24, No. 1, 1-17 (July, 1961).

A field theory is described by two parameter spaces in order to separate the two functions fulfilled by the space-time, i.e. the representation of the degree of freedom of the dynamical system and the specification of the order of measurements. After the two functions of space-time are separated, the author abandons the assumption of the displacement invariance and assumes the momentum-conservation law of finite "range". Further, the assumption of the field is replaced by the assumption of the particle. Then the domain of applicability of the theory is extended so as to be able to describe the elementary particles with finite degree of freedom. Some possible observable effects peculiar to the theory of finite degree of freedom are discussed. The difference between the concept of space-time distance in the existing field theory and that in the proposed theory is mentioned.

10830 ON RADIATIVE CORRECTIONS DUE TO SOFT PHOTONS. T.Murota.
Progr. theor. Phys. (Japan), Vol. 24, No. 5, 1109-17 (Nov., 1960).

It is shown that one can take the contribution from soft photons exactly into account in the calculation of the S-matrix in quantum electrodynamics. The conditions are examined under which the contribution from soft photons to cross-sections is factorized.

ON THE ELECTROMAGNETIC CHARACTERISTICS OF SPACE IN NUCLEAR AND ATOMIC FIELDS. See Abstr. 10766

10831 ELECTROMAGNETIC MASS DIFFERENCE OF ELEMENTARY PARTICLES. H.Katsumori.
Progr. theor. Phys. (Japan), Vol. 24, No. 1, 35-58 (July, 1960).

A study is made of whether the observed mass difference between the members of each charge multiplet, for both baryons and mesons, can be explained in terms of an electromagnetic self-energy. The electromagnetic form factor is introduced to play the role of cutoff factor, and the isospace transformation property of each individual elementary particle is taken into account for the phenomenologically assumed form factor. The following results are obtained from the e^2-order self-energy calculation: (1) The observed neutron–proton mass difference (2.5 m_e) may be explained using the suitable form factor which is assumed to agree with the empirical one for the momentum transfer below 1 BeV/c. The desirable behaviour of the form factor for the higher momentum transfer is shown with a few examples, which may suggest some information about the inner structure of the nucleon. The calculated mass difference has no direct close connection with the root-mean-square radius of the charge or magnetic moment distribution, but strongly depends upon the higher momentum behaviour of the form factor. (2) A similar argument seems favourable for understanding that the observed $\Sigma^+-\Sigma^-$ mass difference is considerably larger (13 m_e), while $(M_{\Sigma^+}+M_{\Sigma^-})/2-M_{\Sigma^0}$ is comparatively small ($\sim$ 1.5 m_e). (3) Both the observed $\pi^\pm-\pi^0$ mass difference (9 m_e) and the observed $K^0(\bar{K}^0)-K^\pm$ mass difference (8 m_e) may also be understood if the suitable form factors are assumed according to the isospace transformation property of each meson. (4) Although no experimental data have been made available about the $\Xi^0-\Xi^-$ mass difference with sufficient accuracy, the argument similar to that for the nucleon leads to some conjectures. Finally, the strong interaction corrections to the mass shift are estimated for the baryons and mesons in the lowest approximation of g^2. This effect cannot be thoroughly neglected, but in most cases it seems to be regarded as a small correction to the main electromagnetic effect.

10832 PROPAGATORS OF A SELF-COUPLED SPINOR FIELD IN EDWARDS AND LIEB'S APPROXIMATION. G.Pócsik.
Nuovo Cimento (Italy), Vol. 20, No. 1, 201-4 (April 1, 1961).

The non-perturbative method of approximation of Lieb (Abstr. 508 of 1958) is applied to the scalar self-coupling of a Fermi field. J.Goldstone

10833 MACROSCOPIC CAUSALITY AND ANALYTICITY OF ELECTROMAGNETIC FORM FACTOR. K.Yamamoto.
Progr. theor. Phys. (Japan), Vol. 23, No. 5, 964-5 (May, 1960).

Arguments to be published by the author are applied to the electromagnetic form factor of the nucleon, and show that it is analytic in the upper half plane as a function of invariant momentum transfer. E.J.Squires

10834 COMPOSITE MODEL AND THE NATURE OF VECTOR INTERACTIONS IN STRANGENESS-VIOLATING DECAYS. C.Iso, M.Kawaguchi and Y.Miyamoto.
Progr. theor. Phys. (Japan), Vol. 24, No. 1, 97-110 (July, 1960).

Decay interactions are discussed in relation to Sakata's composite model (Abstr. 6884 of 1957). in which neutron, proton, and Λ-particle are supposed to be "elementary". Symmetry with respect to n, p, and Λ is also assumed. It is shown that (π K) currents are necessarily added to the usual strangeness violating ($|\Delta S| = 1$) baryon vector currents in the conventional Yukawa type interaction. This is analogous to the situation that ($\pi\pi$) and (KK) currents necessarily appear in the $|\Delta S| = 0$ leptonic decay interaction in the Sakata model. By taking the (πK) currents into account, the transition probabilities for K_{e_3}, K_{μ_3} and beta- and muon-decays of Λ are shown to be consistently described with the same coupling constant as that obtained from $K_{\mu_2}^+$ decay. Thus the coupling constant for strangeness-violating leptonic decays seems to be smaller than that for strangeness conserving ones. For non-leptonic decays the Hamiltonian which guarantees the $|\Delta I| = \frac{1}{2}$ selection rule is easily found by virtue of the additional neutral terms with the universal coupling constant. The lifetimes and branching ratios for non-leptonic decays of Λ and K are in good agreement with experiment in terms of the normal beta-decay coupling constant. The situation is a little complicated for K_{π_3}. Admixture of $|\Delta I| = \frac{3}{2}$ transitions is also briefly discussed. Some comments are made on the observability of $\pi^{0\prime}$, a neutral meson having an isotopic spin 0.

10835 FIELD THEORETICAL INTERPRETATION OF "B-MATTER". I. H.Yamamoto.
Progr. theor. Phys. (Japan), Vol. 24, No. 3, 512-18 (Sept., 1960).

The property of "B-matter", which was introduced in the Nagoya model (Abstr. 3120 of 1961), is studied from the standpoint of current field theory. First, a reasonable interaction Lagrangian is assumed between the B-particle and leptons. Then, the following conditions are required: through this interaction, the proton, neutron and Λ-particle should be constructed as bound states of the B-particle and leptons; furthermore, the β-decay should occur through the same interaction. Results are summarized as follows: the B-particle must have a mass about 10^8–10^9 times the electron mass in order that the above requirements may be fulfilled. It might be possible to describe the strong and weak interactions (excluding the μ-decay) by means of the above interaction in a unified way.

10836 A QUANTITATIVE INVESTIGATION ON THE "COMPOSITENESS" OF A PARTICLE. G.Konisi and K.Yamamoto.
Progr. theor. Phys. (Japan), Vol. 24, No. 4, 817-24 (Oct., 1960).

A quantitative discussion is given concerning to what degree it is plausible to regard a particle as a composite one in the sense of the non-relativistic quantum mechanics of particles (the "compositeness"). For this purpose the probability is calculated that the system is in a state that cannot be regarded as a system of the constituent particles distributed with some probability densities. The main conclusion is that such a probability is proportional to the square root of the binding energy.

10837 ELASTIC ETHER THEORY OF ELEMENTARY PARTICLES. I. CLASSICAL THEORY. H.Fukutome.
Progr. theor. Phys. (Japan), Vol. 24, No. 4, 877-98 (Oct., 1960).

A unified model of elementary particles based upon a renewed idea of "ether" is proposed. In this paper a general classical theory of the relativistic elastic continuum is developed. From the result of the general theory a hypothetical relativistic elastic medium "ether" is introduced. It is an unusual elastic medium which has

no mass and no energy in the undeformed state but has mass and energy in the deformed states which are due entirely to its elastic self-interaction. It is shown that if the ether is elastically isotropic then it has a conserving quantity called "the Lagrange spin" which has very similar properties to that of isospin. It is not conserved if the elastic property of the ether is anisotropic. In this model, the elementary particles are viewed as the excited states of the ether and the strong, electromagnetic and weak interactions are ascribed to the isotropic, cylindrically symmetric and anisotropic elastic self-interaction of the ether, respectively.

10838 STRUCTURE OF RADIATIVE DECAY AMPLITUDES. H.Chew.
Phys. Rev. (USA), Vol. 123, No. 1, 377-81 (July 1, 1961).

It is shown that the matrix element for decay processes involving the emission of a single photon may be obtained from the matrix element for the corresponding nonradiative decay and the magnetic moments of the particles involved, up to terms that vanish as the photon frequency $K \to 0$. Detailed discussions are given for decays involving three and four spinless particles, as well as for four spin $\frac{1}{2}$ particles. The results are similar to those obtained by Low (Abstr. 8960 of 1958) for bremsstrahlung in scattering processes, but some novel features arise when the nonradiative decay is forbidden by selection rules.

10839 COMPOSITE MODEL AND PARTIALLY CONSERVED CURRENTS IN WEAK INTERACTIONS.
S.Okubo and R.E.Marshak.
Phys. Rev. (USA), Vol. 123, No. 1, 382-3 (July 1, 1961).

It is shown that the idea of partially conserved currents has a natural basis in the composite model. Within this framework, the Goldberger–Treiman relation for the pion lifetime is discussed without recourse to dispersion theory.

10840 AN EXAMPLE OF NONLOCAL INTERACTION. Y.Migatake.
Progr. theor. Phys. (Japan), Vol. 23, No. 5, 959-60 (May, 1960).

It is suggested that the finite spread of the charge distribution of the proton, as observed in electron scattering experiments, might give rise to a nonlocal interaction of the type discussed by Markov (Abstr. 6502 of 1959). E.J.Squires

10841 SOME CONSIDERATIONS ON THE PARITY-NON-CONSERVING INTERACTIONS IN THE THEORY OF PROPAGATORS. T.Yoshimura.
Progr. theor. Phys. (Japan), Vol. 23, No. 5, 960-2 (May, 1960).

It is shown that the existence of parity non-conserving terms in a weak interaction Lagrangian, containing only V and A parts, does not necessarily imply that the renormalization factors in the propagators contain parity-violating terms. E.J.Squires

10842 ON THE UNIVERSALITY OF THE WEAK INTERACTIONS. D.Itô, S.Furui, K.Fujii and T.Sakuma.
Progr. theor. Phys. (Japan), Vol. 23, No. 5, 962-4 (May, 1960).

A method is suggested whereby weak interactions can be constructed by a simple substitution in the Lagrangian, analogous to the substitution $\partial_\mu \to \partial_\mu - ieA_\mu/\hbar c$ which yields electromagnetic interactions. It is necessary to introduce a structure, $\sim 10^{-30}$ cm, into the baryons, and to include multipole baryon–meson interaction. The theory gives a satisfactory qualitative explanation of weak interactions, but fails quantitatively. E.J.Squires

10843 I-SPACE PARITY CONNECTION IN NON-LEPTONIC WEAK INTERACTIONS. W.B.Zeleny.
Phys. Rev. Letters (USA), Vol. 6, No. 10, 570-1 (May 15, 1961).

A realization of a recent scheme of Pais (Abstr. 7285 of 1961), involving a connection between parity and a "doublet spin" quantum number, is given. The scheme requires the existence of a scalar and isoscalar neutral meson. E.J.Squires

10844 ON RATIOS OF THE RENORMALIZED AND THE BARE COUPLING CONSTANTS IN THE BETA DECAY INTERACTION. I.Kawakami.
Progr. theor. Phys. (Japan), Vol. 24, No. 1, 27-34 (July, 1960).

The ratio of the renormalized and the bare coupling constants in the β-decay interaction is calculated in two ways. The first is evaluation of the contribution from the process in which a neutron and an antiproton, which virtually exchange an infinite number of pions, are annihilated into an electron–neutrino (or antineutrino) pair. For this purpose a dispersion relation for the vertex function of the β-decay is assumed. Using this relation the ratio is calculated in the "ladder" approximation of Federbush, Goldberger and Treiman (Abstr. 2585 of 1959). The result is that the ratio is smaller than unity. The second way is calculating the ratio so as to include the main contribution from virtual nucleon pairs. For this purpose the author derives an equation for the vertex operator of the β-decay. The vertex operator is calculated using Goto and Machida's approximation (Abstr. 12917 of 1960). The result is that the ratio for the axial vector coupling constants is larger than unity, while that for the vector coupling constants is smaller than unity. The experimental value for the ratio (~ 1.2) is reproduced at a rather small cutoff energy ($\sim$ one-pion rest mass).

10845 SYMMETRY IN SAKATA'S MODEL AND WEAK INTERACTIONS. I.
M.Ikeda, Y.Miyachi and S.Ogawa.
Progr. theor. Phys. (Japan), Vol. 24, No. 3, 569-87 (Sept., 1960).

On the basis of the symmetry theory of Sakata's model (Abstr. 6884 of 1957) some properties concerning various weak interactions are studied. For baryon–meson systems, a scheme is proposed in which a decay can be described by the transitions between various configurations. In this scheme, the conventional selection rule concerning isospin can be understood quite naturally. It is also investigated how the symmetry property possessed by the basic particles is reflected in the β-decay of hyperons and in the K_{e3}-decay.

10846 A POSSIBLE SYMMETRY IN SAKATA'S MODEL FOR BOSONS–BARYONS SYSTEM. III.
M.Ikeda, Y.Miyachi, S.Ogawa, S.Sawada and M.Yonezawa.
Progr. theor. Phys. (Japan), Vol. 25, No. 1, 1-16 (Jan., 1961).

For Pt II, see Abstr. 3119 of 1961. In the full symmetry theory a physical system can be characterized by six quantum numbers (n_B, s_e, i_e; S, I, I_3). Following the original intention of the composite model, the authors try to replace them by other quantum numbers that are easier to understand by intuition. This study leads to a new picture of particles which presents a striking contrast to the usual one in the perturbation theoretical treatment. The results provide a deeper understanding of the full symmetry theory of the composite model and also throw new light on the structure of elementary particles.

10847 CONFERENCE ON STRONG INTERACTIONS. UNIVERSITY OF CALIFORNIA, BERKELEY, CALIFORNIA, DECEMBER 27-29, 1960.
Rev. mod. Phys. (USA), Vol. 33, No. 3, 355-497 (July, 1961).

Twenty-two papers are given, mostly revised or extended versions of those actually presented. Abstracts of the papers will appear in this or subsequent issues of Physics Abstracts.

10848 ON SAKURAI'S THEORY OF THE STRONG INTERACTIONS. P.Hillion and J.P.Vigier.
Cahiers de Phys. (France), Vol. 15, 143-6 (March, 1961). In French.

A French translation of the summary at the start of Sakurai's paper (See Abstr. 3126 of 1961). R.J.N.Phillips

EXTENSION OF THE ISOBARIC NUCLEON MODEL FOR PION PRODUCTION. See Abstr. 10904

10849 THE INVERSE PROBLEM IN THE QUANTUM THEORY OF SCATTERING. L.D.Faddeyev.
Uspekhi mat. Nauk (USSR), Vol. 14, No. 4(88), 57 (1959). In Russian. English translation in: New York Univ., Res. Rep., (USA), No. EM-165, 106 pp. (Dec., 1960).

A review article discussing the mathematical problem involved in the relation between the scattering operator and the potential in a nonrelativistic scattering problem. R.F.Peierls

10850 CHARACTERISTIC COULOMB GREEN'S FUNCTION AND ITS EIGENFUNCTION EXPANSION.
R.A.Mapleton.
J. math. Phys. (USA), Vol. 2, No. 4, 478-82 (July-Aug., 1961).

In the theory of scattering, the Green's function is commonly displayed as an eigenfunction expansion. Here the eigenfunction form is derived from the characteristic form of the Green's function for the non-relativistic Coulomb operator. This derivation shows how the wave boundary condition of the characteristic form of the Green's function is related to the branch cut in the continuous part of the spectrum. An application of the eigenfunction expansion form of this Green's function is discussed.

10851 APPLICATION OF A SINGULAR WAVE-FUNCTION OPERATOR IN SCATTERING THEORY. R.A.Mapleton.
J. math. Phys. (USA), Vol. 2, No. 4, 482-90 (July-Aug., 1961).

A function which is defined in terms of the two-body singular wave-function matrix of Møller acting on a plane-wave state is

lculated. In the paper by Pradhan (Abstr. 4502 of 1957), the nction in question was obtained as the solution of a differential uation. Here, it is found that the function has a normalization hich is different from the one assumed by Pradhan, and this ehaviour is attributed to the long-range character of the Coulomb otential that is in the Møller operator. An intermediate result of is paper agrees with the momentum—space solution of the non-elativistic Coulomb two-body scattering problem which recently ppeared in a paper published by Okubo and Feldman (Abstr. 3923 f 1960). As they show, the wave-function must be renormalized o obtain the correct cross-section, and this view is adopted in is paper. Consequently, the normalization assumed by Pradhan s reinstated. The Legendre expansion coefficients are calculated or the function, $(a - b\cos\theta)^{-c}$.

10852 MODIFICATION OF EFFECTIVE-RANGE THEORY IN THE PRESENCE OF A LONG-RANGE (r^{-4}) POTENTIAL. T.F.O'Malley, L.Spruch and L.Rosenberg.
. math. Phys. (USA), Vol. 2, No. 4, 491-8 (July-Aug., 1961).

For short-range potentials, there exists the effective-range theory expansion $k^{2L+1}\cot\eta(L) = 1/A(L) + \frac{1}{2}r_0(L)k^2 + \ldots$, where $\eta(L)$ is the hase shift for angular momentum L. For long-range potentials potentials which vanish at large r only as some power of 1/r), an expansion in k^2 does not exist. For $V(r) \to \text{const} \times r^{-n}$ for $r \to \infty$, he term at which the expansion breaks down depends upon L and upon n; A(L) cannot be defined if $n \leq 2L + 3$, while for example for L = 0 one cannot define r_0 in the usual way if $n \leq 5$. A detailed study is made of the case n = 4. This case is of considerable interest since it arises, in the adiabatic approximation, in the scattering of a charged particle by a neutral polarizable system; the present analysis is concerned with the scattering by a static potential, but it can be readily generalized to include scattering by a compound (polarizable) system. The analysis is very much simplified by the existence of known mathematical solutions, Mathieu functions, of the Schrödinger equation with V(r) equal to const $\times r^{-4}$. The expansion of k $\cot\eta$ (0) about E = 0 contains a number of terms not present in the usual effective-range theory, including a term linear in k. The expansion about the energy of a weakly bound state does not contain these additional terms. It is rather of the usual form, but the correction will be of lower order than k^4. The leading terms in the expansion of $k^3\cot\eta$ (L) for $L \neq 0$ are also obtained.

10853 THE MOST PROBABLE PATH OF A SCATTERED PARTICLE. N.C.Barford.
Nuovo Cimento (Italy), Vol. 18, No. 6, 1274-6 (Dec. 16, 1960).

A method is given for finding the most probable path of a particle through a plate of scattering material, in terms of its initial and final directions. E.J.Squires

10854 PROPERTIES OF NORMAL THRESHOLDS IN PERTURBATION THEORY. Tai Tsun Wu.
Phys. Rev. (USA), Vol. 123, No. 2, 689-91 (July 15, 1961).

Making use of the relation between a Feynman diagram and the corresponding electric circuit, several properties of the normal thresholds are established.

10855 SINGULARITIES OF SCATTERING AMPLITUDES ON UNPHYSICAL SHEETS AND THEIR INTERPRETATION. R.Blankenbecler, M.L.Goldberger, S.W.MacDowell and S.B.Treiman.
Phys. Rev. (USA), Vol. 123, No. 2, 692-9 (July 15, 1961).

The analytic structure of two-particle scattering amplitudes on the unphysical sheet of the Riemann surface reached by crossing the two-particle cut is discussed. The singularities of the amplitudes there are shown to be poles and their physical interpretation is studied. The way in which bound states appear on the physical sheet in the Mandelstam representation, both as isolated poles and as cuts, is traced in detail. The properties of partial wave amplitudes and of the full amplitude as a function energy and angle and of energy and momentum transfer are discussed. Finally, a few remarks are made in connection with unstable states.

10856 ENERGY SPECTRUM AND SCATTERING PROBLEM IN QUANTIZED FIELD THEORY. S.Azuma.
Progr. theor. Phys. (Japan), Vol. 24, No. 4, 689-720 (Oct., 1960).

It is shown that the scattering problem can be formulated in terms of a generating operator with respect to the variation of the coupling parameter which is contained in the Hamiltonian. This formalism makes the rigorous treatment of such problems possible concerning the self energies of closed systems as well as the scattering between bound states. One can further obtain a certain general relation concerning the phase shifts and levels, which includes the field theoretical generalization of Levinson's theorem (Abstr. 5961 of 1949).

10857 MACROSCOPIC CAUSALITY AND LOWER LIMIT FOR THE MOMENTUM DERIVATIVE OF THE SCATTERING PHASE SHIFT. T.Ogimoto.
Progr. theor. Phys. (Japan), Vol. 24, No. 5, 949-52 (Nov., 1960).

Some investigations are made for a lower bound of the momentum derivative of the scattering phase shift on the basis of macroscopic causality in quantum field theory.

10858 NOTE ON REARRANGEMENT COLLISIONS. T.B.Day, L.S.Rodberg, G.A.Snow and J.Sucher.
Phys. Rev. (USA), Vol. 123, No. 3, 1051-3 (Aug. 1, 1961).

The conventional Born approximation formula for rearrangement collisions is used extensively in both atomic and nuclear physics. This formula contains a direct contribution from the heavy-particle of "core" interaction. A straightforward demonstration shows that for the usual case of a massive core this contribution does not appear, so that only the only effect of this interaction is to distort the incident and outgoing waves. Such problems as the "post-prior" discrepancy are clarified.

10859 ON THE THEORY OF REARRANGEMENT COLLISIONS. S.Sunakawa.
Progr. theor. Phys. (Japan), Vol. 24, No. 5, 963-79 (Nov., 1960).

The formal theory of rearrangement collisions is developed from the standpoint of the S-matrix, and is formulated in such a way that the asymptotic Hamiltonian is the same for the final and initial states. The orthogonality of these states makes it possible to formulate the theory of rearrangement collisions in a way similar to that of single potential scattering. The "prior—post" discrepancy is discussed and the generalized optical theorem is derived.

10860 SPACE-TIME DESCRIPTION OF COLLISION AND DECAY PROCESSES. M.Ida.
Progr. theor. Phys. (Japan), Vol. 24, No. 6, 1135-48 (Dec., 1960).

On the basis of Lorentz invariance and the existence of the vacuum, scattering amplitudes are expressed in terms of Wightman functions. This is done with the aid of observation functions, four-dimensional wave packets vanishing outside the space-time regions of observation of colliding particles. Restrictions must be imposed on each of these regions in order to assure the one-particle character of observed particles, which may be either stable or unstable. The expression obtained, in a form modified under the additional assumption of microcausality, is compared with that of Lehmann, Symanzik and Zimmermann (Abstr. 1510 of 1955; 8376 of 1957) and the physical meaning of the asymptotic condition is clarified. Extension of this method of description to processes involving composite particles is given, and some relativistic problems concerned with unstable particles are also discussed from this space-time point of view.

10861 ASYMPTOTIC BEHAVIOR AND SUBTRACTIONS IN THE MANDELSTAM REPRESENTATION. M.Froissart.
Phys. Rev. (USA), Vol. 123, No. 3, 1053-7 (Aug. 1, 1961).

It is proved that a two-body reaction amplitude involving scalar particles and satisfying Mandelstam's representation is bounded by expressions of the form $Cs\ln^2 s$ at the forward and backward angles, and $Cs^{3/4}\ln^{3/2}s$ at any other fixed angle in the physical region, C being a constant, s being the total squared c.m. energy. This corresponds to cross-sections increasing at most like $\ln^2 s$. These restrictions limit the freedom of choice of the subtraction terms to six arbitrary single spectral functions and one subtraction constant.

10862 ON THE VALIDITY OF MULTIPLE DISPERSION REPRESENTATIONS. N.Nakanishi.
Progr. theor. Phys. (Japan), Vol. 24, No. 6, 1275-95 (Dec., 1960).

The validity of multiple dispersion representations are investigated in perturbation theory. The lowest-order vertex function is analysed as functions of two and three variables. A conjecture is proposed for the possibility of double dispersion representations. As an application of the double dispersion representation, the Bethe—Salpeter equation in ladder approximation is solved in the case of total mass zero.

10863 ON THE METHOD OF THE THEORY OF NUCLEAR FORCES. M.Taketani and S.Machida.
Progr. theor. Phys. (Japan), Vol. 24, No. 6, 1317-24 (Dec., 1960).

The method of the theory of the nuclear forces proposed by Taketani et al. (Abstr. 7964 of 1952) is developed to clarify the

present stage of the theory of the nuclear forces and to discuss the aims, as well as the important results obtained up to the present, of the theoretical investigations in progress at Rikkyo University, Tokyo, as part of a programme organized by the Research Institute for Fundamental Physics, Kyoto University.

10864 TWO NUCLEON POTENTIAL WITH FULL RECOIL. I. GENERAL FORMALISM AND ONE-PION-EXCHANGE POTENTIAL. N.Hoshizaki and S.Machida.
Progr. theor. Phys. (Japan), Vol. 24, No. 6, 1325-48 (Dec., 1960).

The nonstatic nuclear potential due to the one-pion-exchange process is derived in momentum space without using the expansion with respect to the inverse of the mass of the nucleon. Close examination of its properties shows that it can be expressed with good accuracy by a local potential in x-space at low energies (below nearly 300 MeV). Nonstatic parts of the potential have different signs according as whether the assumed coupling between the pion and the nucleon is pseudoscalar or pseudovector. Comparison with the experimental phase shifts is briefly discussed. It is shown in the case of the pseudoscalar coupling that the nonstatic one-pion-exchange potential derived in this paper is almost exact from the theoretical point of view when the distance between two nucleons is large enough (large compared with one third of the pion Compton wavelength). It is argued on some physical assumptions that the potential will also be exact in the case of the pseudovector coupling.

10865 NUCLEAR FORCES IN THE MOMENTUM SPACE. J.Goto and S.Machida.
Progr. theor. Phys. (Japan), Vol. 25, No. 1, 64-82 (Jan., 1961).

Several fundamental problems of a two-nucleon system in momentum space are discussed in the hope that they will be useful for treating the two-nucleon problem completely nonstatically, i.e. without making use of the expansion in terms of the inverse of the mass of the nucleon. General forms for a two-nucleon potential in momentum space are derived, and the integral equations which are the Fourier transform of the Schrödinger equation and their solutions are briefly discussed. Formulae for matrix elements of the most general types of potentials are evaluated and are applied to the nonstatic one-pion-exchange potential.

10866 NUCLEAR POTENTIAL IN MANY-BODY PROBLEMS. J.Osada and M.Takeda.
Progr. theor. Phys. (Japan), Vol. 24, No. 4, 755-60 (Oct., 1960).

The authors investigate whether the nuclear potential in the many-body system is the same as that in the two-body system. At first sight, it seems that the nuclear potentials are different in these two cases, because the momenta of mediating mesons are limited due to the Pauli principle in the case of many-body systems. It is concluded, however, that the energy of a nucleon gas can be calculated correctly by using the T.M.O. potential (Abstr. 7963 of 1952) which is constructed under the assumption of the existence of only two nucleons, and that extra many-body forces must not be introduced into the system in addition to the above two-body potential. For simplicity, an idealized nucleon gas is considered which interacts with a symmetrical scalar meson field so weakly that the perturbation-theoretic treatment is justified.

ELEMENTARY PARTICLES

10867 SEARCH FOR POSITIVE PARTICLES OF MASSES ABOUT 500 m_e AND 1400 m_e.
V.Cook, D.Keefe, L.T.Kerth, P.G.Murphy, W.A.Wenzel and T.F.Zipf.
Phys. Rev. (USA), Vol. 123, No. 2, 655-6 (July 15, 1961).

The mass spectrum of positive particles in a secondary beam from the Bevatron was measured at a distance of 90 ft from the internal target. At a confidence level of 93% the proportion of particles with mass between $420m_e$ and $630m_e$ in the 1 BeV/c beam is estimated to be $< 6 \times 10^{-6}$. An upper limit of about 3×10^{-6} is obtained for the proportion of particles of mass approximately $1400m_e$ in the 2.3 BeV/c beam.

10868 ANGULAR ASYMMETRY THEOREMS FOR DECAY PRODUCTS. M.Peshkin.
Phys. Rev. (USA), Vol. 123, No. 2, 637-41 (July 15, 1961).

The method of Eberhard and Good (Abstr. 20226 of 1960), for using decay angular distributions to determine the spins of unstable systems, is developed. Their inequality, which expresses the impossibility of getting too symmetric a decay pattern from an asymmetric initial state, is tightened. The results are generalized to include spinning decay products. The Adair analysis (Abstr. 4[illegible] of 1956) is generalized in the same framework.

Photons

10869 AN EXPERIMENTAL STUDY OF GAMMA-RAY BACK-SCATTERING USING SCINTILLATION GAMMA-RAY SPECTROSCOPY. J.Baarli.
Arch. Math. Naturvid. (Norway), Vol. 55, No. 8, 121-227 (1961).

The general theory of backscattering of γ-radiation is discussed together with the present state of experimental information on this topic. A method is described using scintillation counters for analysing the spectral composition of backscattered γ-radiation. Results are presented for the backscattering of Au^{198}(411 keV), Cs^{137}(662 keV) and Co^{60}(1250 keV) γ-rays from pressed wood (tissue equivalent), aluminium and iron. Measurements were made of the energy spectrum, angular distribution, ratio of total reflected photon energy to incident energy, and ratio of the total number of reflected photons to number of incident photons. The results for iron are in good agreement with calculations carried out by Monte Carlo methods. R.E.Mea[illegible]

MIXING RATIO OF THE 440 keV GAMMA RADIATION IN Na^{24}. See Abstr. 11014

GAMMA-RAY SPECTRA IN LARGE ORGANIC SCINTILLATORS. See Abstr. 10810

10870 A NETWORK APPROACH TO THE ANALYSIS OF ČERENKOV RADIATION PROBLEMS. COMMENT ON THE PAPER "ON THE THEORY OF SOME ČERENKOVIAN EFFECTS" BY G.TORALDO DI FRANCIA.
L.B.Felsen and A.Hessel.
Nuovo Cimento (Italy), Vol. 19, No. 5, 1065-71 (March 1, 1961).

Sketch of a network derivation of the modal representation for the particle field in plane stratified isotropic regions. Toraldo di Francia's treatment of Cherenkov radiation from charges in motion near dielectric media (Abstr. 12902 of 1960) emerges as a special case. T.Erb[illegible]

CHERENKOV EFFECT IN PLASMA. See Abstr. 10704

10871 THE THEORY OF ELECTRON BREMSSTRAHLUNG AT PROTONS. H.L.Vÿsots'kÿi and A.A.Kresnin.
Ukrayin. fiz. Zh. (USSR), Vol. 4, No. 2, 164-6 (1959). In Ukrainian.

The differential cross-section is calculated, taking into account the anomalous magnetic moment of the proton. A phenomenological account of the proton form factor is given.

COULOMB FIELD EFFECTS IN BREMSSTRAHLUNG PROCESSES ASSOCIATED WITH β-DECAY. See Abstr. 10980

10872 ISOTHERMAL GAMMA CALORIMETER. A.P.Komar and Z.Kovarzh.
Zh. tekh. Fiz. (USSR), Vol. 31, No. 1, 116-24 (Jan., 1961). In Russian.

For abstract, see Abstr. 5706 of 1961. [English translation in Soviet Physics—Technical Physics (USA), Vol. 6, No. 1, 83-9 (July, 1961)].

X-rays

10873 ABSOLUTE MEASUREMENT OF AVERAGE ENERGY LOST BY VERY SOFT X-RAYS PER ION PAIR IN AIR. B.Rajewsky and D.Lang.
Nature (GB), Vol. 190, 249-50 (April 15, 1961).

Previous measurements of the average energy loss per ion pair (W) displayed large discrepancies at energies below about 10 keV. New measurements made with a scintillation counter and balanced filter method show no significant dependence of W on X-ray quantum energy within the range 5.89-17.44 keV, and give a mean value of 35.0 ± 0.5 eV per ion pair. V.E.Cossl[illegible]

10874 CORRECTION FOR NONLINEARITY IN X-RAY COUNTING SYSTEMS. R.D.Burbank.
v. sci. Instrum. (USA), Vol. 32, No. 3, 368-70 (March, 1961).
It is shown that if Short's method for correcting X-ray count-es (Abstr. 11139 of 1960) is to be used, the true transmission efficient of the absorber must be known with extreme accuracy.
A.E.I. Research Laboratory

eutrinos

NEUTRINO AND COSMOLOGY. See Abstr. 10369

10875 ANNIHILATION PROCESS OF NEUTRINO PRODUCTION IN STARS. H.Y.Chiu.
ys. Rev. (USA), Vol. 123, No. 3, 1040-50 (Aug. 1, 1961).
The rate at which the energy of a blackbody radiation is con-erted into neutrinos by the pair annihilation process $e^- + e^+ \rightarrow \nu + \bar{\nu}$ was calculated. At $T \sim 6 \times 10^{9\,0}$K the relaxation me for such conversion process is around 100 sec for pure adiation. Since neutrinos have a very long mean free path ≫ stellar dimensions) they will escape, thus carrying away the nergy. This process therefore will be of astrophysical importance. he rate of energy loss dU/dt is tabulated, as a function of tempera-ure and density, together with the chemical potential, the pressure, nd the electron—positron energy. This table should be useful for umerical integrations of stellar structure equations in the tempera-ure range (0.5-10) $\times 10^{9\,0}$K, and the density range $0\text{-}10^6$ g/cm^3.

lectrons

10876 SOME THEORETICAL PROBLEMS CONCERNING ELEMENTARY PARTICLES. P.Merat.
ahiers de Phys. (France), Vol. 15, 1-55 (Jan., 1961). In French.
University of Paris thesis. Describes an 8-dimensional real pinor theory of the electron. Studies an extension of this formalism i sixteen dimensions, and a possible unified description of other articles.
R.J.N.Phillips

10877 BUSCH TUBE FOR DETERMINING e/m FOR THE ELECTRON. H.V.Neher.
Amer. J. Phys., Vol. 29, No. 8, 471-5 (Aug., 1961).
A tube is described which is fabricated from parts readily available to most departments of physics. With the proper auxiliary equipment, it is possible to determine the ratio of charge to mass of the electron to 0.2-0.3% in a reasonable time. It is of additional interest that from the data giving the magnetic field of the solenoid, a value for the earth's magnetic field may be obtained.

10878 NUCLEON POLARIZABILITY CORRECTION TO HIGH-ENERGY ELECTRON-NUCLEON SCATTERING. N.R.Werthamer and M.A.Ruderman.
Phys. Rev. (USA), Vol. 123, No. 3, 1005-13 (Aug. 1, 1961).
The contribution of nucleon polarizability to ultrarelativistic electron—nucleon scattering cross-sections is estimated and found to be small for non-forward scattering angles at all energies.

10879 DETERMINATION OF THE RANGE OF 20.4 MeV ELECTRONS. G.Harigel, M.Scheer and K.Schultze.
Z. Naturforsch. (Germany), Vol. 16a, No. 1, 132 (Jan., 1961). In German.
Describes measurements of the range of 20.4 MeV electrons in Freon.
R.H.Thomas

RELATIVISTIC ELECTRON-PAIR SYSTEMS AND THE STRUCTURE OF NEUTRAL MESONS. See Abstr. 10901

Nucleons

10880 THE THEORY OF THE NUCLEON LEVEL STRUCTURE IN TERMS OF THE PION—PION RESONANCE. I.
K.Itabashi, M.Kato, K.Nakagawa and G.Takeda.
Progr. theor. Phys. (Japan), Vol. 24, No. 3, 529-54 (Sept., 1960).
The existence of a sharp π—π resonance is assumed for the T = j = 1 state at about 600 MeV. This resonance state is approximately replaced by a real T = j = 1 particle $\rho^{\pm,0}$ and its interactions with the pion field and the electronmagnetic field are determined. The calculation of pion—nucleon scatterings through ρN intermediate states shows in the Born approximation that very strong attractive forces seem to exist for both $T = \frac{1}{2}$, $d_{3/2}$ and $T = \frac{1}{2}$, $f_{5/2}$ pion—nucleon states at about the ρ-production threshold energy. The former is identified as the second and the latter as the third resonance observed in the pion—nucleon scatterings. A similar calculation predicts the possible appearance of the second resonance and the suppression of the third one in photo-pion production. A tentative model for explaining the fourth maximum observed in pion—nucleon scattering is proposed on similar lines.

10881 ELECTROMAGNETIC STRUCTURE OF THE NUCLEON. K.Kawarabayashi and S.Machida.
Progr. theor. Phys. (Japan), Vol. 25, No. 1, 17-34 (Jan., 1961).
Spectral representations of the electromagnetic form factors of the nucleon for fixed momentum transfer are proved as a function of the square of the four-momentum of the nucleon; based on the general principles of the quantum field theory and, using these representations, two sets of coupled equations for charge and magnetic moment form factors are derived. These equations are solved in an approximation in which only the lowest mass configuration is taken into account, consisting of one pion and one nucleon. It is shown that the absorptive parts in this approximation are expressed in terms of the real pion production by virtual photon for $I = J = \frac{1}{2}$ state and pion—nucleon vertex part, from which it follows that (3-3) resonant state does not contribute to the form factors as far as the lowest mass configuration is concerned. Inclusion of (3-3) resonance and the second and third resonance requires the calculation of two pions and one nucleon state, which is not attempted in this paper.

ELECTROMAGNETIC FORM FACTOR OF THE NUCLEON. See Abstr. 10833

COLLECTIVE CORRELATION BETWEEN VACUUM NUCLEONS. See Abstr. 10920

10882 THE PROTON—NEUTRON MASS DIFFERENCE AND THE INNER STRUCTURE OF THE NUCLEON.
T.Kanki and K.Yamamoto.
Progr. theor. Phys. (Japan), Vol. 24, No. 1, 135-48 (July, 1960).
A method is proposed which makes it possible to take into account the contribution from the pair state in the calculation of the proton—neutron mass difference without regard to the form of the matrix elements related to the pair state. It is shown that there exists a considerable difference between the result of this method and that of the Feynman—Speisman method (Abstr. 7123 of 1954) in the internal region of the nucleon cloud. The model of form factors is considered in which the core exists only in the charge isoscalar part. The result derived from this model is not satisfactory owing to the wrong sign of the mass difference. In order to get a good agreement with the empirical data it would be necessary to introduce a core at least into one of the form factors of the charge isovector type and of any kind of the magnetic moment type. The magnitude and the sign of the core is briefly estimated for each type of form factors.

10883 A POSSIBLE INTERPRETATION OF HIGH ENERGY NUCLEAR EVENTS.
N.Yajima, S.Takagi and K.Kobayakawa.
Progr. theor. Phys. (Japan), Vol. 24, No. 1, 59-80 (July, 1960).
A method of analysing the data of high-energy jet showers in nuclear emulsions is proposed. The possibilities of reducing the nucleon—nucleon collisions to pion—nucleon interactions are discussed. Using the experimental data on π^-—p collisions at 5 GeV as the pion—nucleon interaction, one can estimate the energy and angular distribution of emitted pions in rather low-energy jet showers ($< \sim 100$ GeV) and the obtained results agree fairly well with experiments. As to the high-energy jet showers ($> \sim 100$ GeV) one can conclude that almost all of collisions may be regarded as peripheral ones and that the properties of the pion—nucleon interaction reduced from the nucleon—nucleon collisions are similar to those of the pion—nucleon interaction actually observed. It is also suggested that the nucleon has a core whose radius is about a nucleon Compton wavelength.

TWO NUCLEON POTENTIAL WITH FULL RECOIL. See Abstr. 10864

10884 TRANSITION MATRIX FOR NUCLEON—NUCLEON SCATTERING. K.L.Kowalski and D.Feldman.
J. math. Phys. (USA), Vol. 2, No. 4, 499-511 (July-Aug., 1961).
As part of a study of the influence of off-the-energy-shell effects on the optical potential for nucleon—nucleus scattering, a

method is presented for the calculation, via the reactance matrix, of the nucleon—nucleon transition matrix in terms of an inter-nucleon potential and the scattering amplitude. The singular integral equations for the partial-wave amplitudes of the reactance matrix are reduced to a Fredholm form which contains the scattering amplitude parametrically. The iteration solution of these Fredholm equations is shown to be generally unreliable; however, the zeroth-order iteration approximates the exact solution quite well near the energy shell. The replacement of the kernels of these integral equations by separable functions is discussed; the validity of such an approximation is illustrated by a simple example. The requirement that the solutions of the (exact) Fredholm equations be consistent with the original singular integral equations yields a solution for the scattering amplitude in terms of the resolvent kernels of the Fredholm equations. The entire formalism is so constructed as to include the possibility of a hard core being present in the nucleon—nucleon interaction.

10885 ON THE NUCLEON—NUCLEON SCATTERING PHASE SHIFTS AND THE HIGH ENERGY NUCLEONS ELASTICALLY SCATTERED FROM LIGHT NUCLEI. Y.Sakamoto.
Progr. theor. Phys. (Japan), Vol. 24, No. 4, 783-96 (Oct., 1960).

The polarizations and triple-scattering parameters of the nucleons elastically scattered from light nuclei are explained with the optical-model potential by the use of the nucleon—nucleon scattering phase shifts. The set of two-body scattering phase shifts meson-theoretically derived gives a small magnitude for the parameter of optical model potential V_{SR}. The small value of V_{SR} is mainly caused by the large positive $^3P_0$ state phase shift of the two-body scattering. The small value of V_{SR} gives a small polarization and a small absolute value of the triple scattering parameter for nucleons scattered from the potential. Furthermore, the value of

$$\left|\frac{V_s}{V_c}\right|(\hbar/\mu c)^2$$

calculated by the use of the meson-theoretical phase shifts is smaller than the ones based on the Gammel—Thaler and Signell—Marshak phase shifts. This difference is mainly due to the difference of $^3P_0$ state phase shifts in the two-body scattering.

Protons

PROTON CHARGE DISTRIBUTION. See Abstr. 10840

10886 MAGNETIC MOMENT OF THE PROTON IN UNITS OF THE NUCLEAR MAGNETON.
H.S.Boyne and P.A.Franken.
Phys. Rev. (USA), Vol. 123, No. 1, 242-54 (July 1, 1961).

A new method for measuring the magnetic moment of the proton in units of the nuclear magneton is described. The method differs from the work of others in that the cyclotron frequency of free low-energy H_2^+ ions is measured with a low-power absorption technique as a function of magnetic field. The extrapolation technique of Franken and Liebes (Abstr. 3542 of 1957) is utilized to correct for shifts produced by electrostatic fields. The measurements yield $\mu_p(H_2O)/\mu_n = 2.792\,83 \pm 0.000\,06$. This determination is approximately 50 p.p.m. higher than the results of other workers.

Neutrons

THE USE OF THE TERM "FLUX". See Abstr. 9696

10887 THE ELECTRIC POLARIZABILITY OF THE NEUTRON.
T.Ueda and M.Sawamura.
Progr. theor. Phys. (Japan), Vol. 24, No. 3, 519-28 (Sept., 1960).

The electric polarizability is calculated by the relativistic meson theory in the lowest order of perturbation method. A cutoff calculation is also examined. There are remarkable cancellations among the large contributions from the pion current so that those from the nucleon currents and from the K-meson interactions become important. The electric polarizability obtained is several times as large as 10^{-43} cm^3 and is expected not to exceed 10^{-42} cm^3. The Foldy term, static theory and the problem of mass difference are discussed.

10888 ANGULAR DISTRIBUTION OF n—p SCATTERING AT 14.1 MeV. T.Nakamura.
J. Phys. Soc. Japan, Vol. 15, No. 8, 1359-66 (Aug., 1960).

The angular distribution for the scattering of neutrons by protons was obtained by observing the recoil protons with the use of a counter-telescope consisting of a polyethylene target, two proportional counters and a CsI scintillator. The data obtained at scattering angles of 165°, 146°, 118° and 89° in the C.M.-system were given with statistical errors of about 1%. The ratio of the cross-sections at 180° and 90° in the centre-of-mass system was found to be 1.080 ± 0.016 from a least square fit to the form $A + B\cos^2\theta$. It is concluded that anisotropy of the angular distribution is confirmed. The absolute values of differential cross-sections at various angles were normalized using the total cross-section, 689 ± 5 mb, measured by transmission. The values are in good agreement with the results predicted from the nuclear potentials with a "one-pion-exchange-tail" proposed by members of the Nuclear Force Group in Japan.

10889 A STUDY ON THE LOW ENERGY n—p SYSTEM.
T.Hamada.
Progr. theor. Phys. (Japan), Vol. 24, No. 1, 126-34 (July, 1960).

Deuteron properties and the zero-energy n—p scattering parameters are computed for a number of potentials. These potentials are characterized by the one-pion-exchange tail and the semi-phenomenological inner interaction. The numerical results provide a basis on which one can estimate the consequence of any reasonable potential consistent with the pion theory, as far as the low energy n—p system is concerned.

QUASI-ELASTIC SCATTERING OF COLD NEUTRONS BY WATER. See Abstr. 9386

10890 EXACT SOLUTION OF A CRITICAL PROBLEM FOR A SLAB. R.Żelazny.
J. math. Phys. (USA), Vol. 2, No. 4, 538-42 (July-Aug., 1961).

By using the Case method of expansion of the angular neutron distribution into series with respect to eigenfunctions of the plane Boltzmann equation (Abstr. 3471 of 1960), the critical problem of a slab was formulated. By means of symmetry considerations, the problem of boundary condition was reduced to one singular integral equation, which has been treated by classical methods. This treatment has given an integral equation for expansion coefficients, which by means of a simple transformation can be reduced to a Fredholm type with a regular kernel, and an additional equation, which plays the role of an exact critical condition. The methods and results of numerical calculations will be published soon.

10891 TSCHEBYSCHEFF [CHEBYSHEV] POLYNOMIAL APPROXIMATION METHOD OF THE NEUTRON-TRANSPORT EQUATION. S.Yabushita.
J. math. Phys. (USA), Vol. 2, No. 4, 543-9 (July-Aug., 1961).

The Chebyshev polynomial approximation method of the neutron transport equation is developed. The relations between the relaxation constants in this approximation and the positive roots of $T_{N+1}(\mu) = 0$ are derived. Using these relations, the necessary condition for reactor criticality is discussed. Application to Milne problem leads to an explicit expression for extrapolated end point which is formally the same in the spherical harmonics method. Numerical comparison of this method with the spherical harmonics method verifies Conkie's conclusion (Abstr. 15363 of 1960) that, for weak absorbers, the spherical harmonics method gives the values for extrapolated end point which is closer to the exact value than the T_N method does while, for strong absorbers, the T_N method gives closer value than the P_L method does.

10892 CALIBRATION OF A NEUTRON SOURCE.
D.T.Elbrus.
Rev. Fac. Sci. Univ. Istanbul C (Turkey), Vol. 25, No. 1-2, 40-6 (Jan.-April, 1960). In German.

The photographic method was applied to the measurement of the thermal neutron spectrum of a water moderated source.

S.J.St-Lora

NEUTRON SELF SHIELDING. See Abstr. 11045

10893 CONSTRUCTION AND ABSOLUTE CALIBRATION OF A PHOTONEUTRON STANDARD.
C.P.Galotto, T.Gerevini, F.Romanisio and F.Toselli.
Energia nucleare (Italy), Vol. 8, No. 4, 243-6 (April, 1961).

A photoneutron standard Ra-γ-Be was developed consisting of a 4 cm diameter beryllium sphere carrying at its centre 251.8 mg

Ra. The paper describes the calibration experiment by a physical tegration method. The saturation activity of a 10% $MnSO_4$ aqueous olution irradiated in the absence and in the presence of a lattice polythene tubes filled with gold powder was measured, as was .e absolute average activity of gold by coincidence measurements. he source strength was found to be $(3.11 \pm 0.07) \times 10^6$ neutrons/sec.

10894 USE OF RING-SHAPED NEUTRON SOURCES IN A RESEARCH REACTOR.
.N.Cooper, K.Firth and K.G.Stephens.
rit. J. appl. Phys., Vol. 12, No. 6, 298-9 (June, 1961).

Measurements were made of the effectiveness of the ring haped neutron sources for the Merlin reactor. The emission rate f one neutron source was measured absolutely at the National 'hysical Laboratory and the remaining sources were compared with iis standard. A neutron to gamma ratio of $(0.7 \pm 0.1) \times 10^6$ n/s er curie of Sb^{124} was obtained. The effectiveness of the sources as found by measuring the power generated in a sub-critical core. .his result was in reasonable agreement with a calculation, based n two-group diffusion theory.

10895 NEUTRON SPECTROMETER FOR PRODUCING PURE MONOCHROMATIC BEAMS IN THE THERMAL tEGION. H.B.Møller, F.J.Shore and V.L.Sailor.
tev. sci. Instrum. (USA), Vol. 32, No. 6, 654-8 (June, 1961).

The combination of a Si (111) monochromator and a quartz 'single-crystal" filter proves effective for the elimination of ligher-order contamination from the monochromatic beam of a ieutron crystal spectrometer in the energy range from ~0.02-0.10 eV. This system greatly enhances the usefulness of :rystal spectrometers for obtaining cross-section data in the .hermal range. The properties of the quartz filter were studied it room temperature and 77°K, and it is shown that the filter is nore efficient in this application at room temperature. The higher-)rder contaminations from Si (111) and NaCl (200) reflections are :ompared, and it is clearly demonstrated that Si (111) is a superior nonochromator in the thermal region.

10896 EFFECT OF REFLECTION ON THE PERFORMANCE OF MECHANICAL NEUTRON MONOCHROMATORS.
L.Passell, W.C. Dickinson and W.Bartolini.
Rev. sci. Instrum. (USA), Vol. 32, No. 7, 870-1 (July, 1961).

Calculations of the critical angle of reflection and the effective glancing angle for a moving monochromator wall indicate that the rotor should be made of a material with a small coherent and a large incoherent and/or absorption cross-section, such as a plastic with H/C = 1.77. E.J.Burge

10897 MEASUREMENT OF THE SLOW NEUTRON SPECTRUM OF A NEUTRON BEAM FROM THE W.W.R.S. REACTOR BY MEANS OF A CRYSTAL NEUTRON SPECTROMETER. D.A.O' Connor and J.Sosnowskii.
Acta phys. Polon. (Poland), Vol. 19, No. 3, 329-38 (1960).

The efficiency of a crystal neutron spectrometer was determined experimentally using a double crystal arrangement. On the basis of these results the slow neutron spectrum of a neutron beam was determined in the range of neutron wavelength 0.5-2.5 A. The variation of crystal reflectivity with wavelength was compared with a theoretical expression for this dependence.

Mesons

10898 ON THE POSSIBILITY OF THE EXISTENCE OF A NEW MESON. C.Iso and T.Kobayashi.
Progr. theor. Phys. (Japan), Vol. 24, No. 6, 1215-23 (Dec., 1960).

A new meson, λ^0, which interacts only with the Λ-particle, is introduced to explain the mass difference between the Λ-particle and the nucleon. The requirement that the self-energy of the Λ-particle be positive restricts the type of λ^0-meson to three possibilities, V(v), V(t) or PS(ps). Some properties of the λ^0-meson as well as ideas for possible experimental verification of its existence are discussed.

10899 ELASTIC SCATTERING OF MUONS IN NUCLEAR EMULSION. P.L.Connolly, J.G.McEwen and J.Orear.
Phys. Rev. Letters (USA), Vol. 6, No. 10, 554-6 (May 15, 1961).

The μ^+ stack was exposed in the 43 MeV beam of the Carnegie synchrocyclotron, and the μ^- stack in the 60 MeV beam of the Cern synchrocyclotron. The μ^+ data was analysed and gives the differential cross-section $\sigma(\theta)$ in the range $\theta = 80^0 - 180^0$ for muons of energy between 14 and 40 MeV. A plot of $\sigma(\theta)$ against momentum transfer fits with the average charge distribution for Ag and Br. It is concluded that μ^+ behave as e^+, and that the r.m.s. muon radius is $< 1.7 \times 10^{-13}$ cm. A.Ashmore

10900 THE ENERGY LOSS OF SINGLY CHARGED HEAVY RELATIVISTIC PARTICLES IN AN ORGANIC MATERIAL. C.F.Barnaby.
Proc. Phys. Soc. (GB), Vol. 77, Pt 6, 1149-56 (June, 1961).

An experiment is described in which a large-area plastic scintillation counter is used to measure the energy loss of relativistic μ-mesons. The results, which are not dependent on the particular method used to fit them to the Landau distribution, show that the increase in the most probable energy loss is less than 1% for mesons of energies between 500 and at least 10 000 MeV. This conclusion is consistent with the Sternheimer density correction to the ionization loss theory of Bethe–Bloch.

10901 RELATIVISTIC ELECTRON-PAIR SYSTEMS AND THE STRUCTURE OF NEUTRAL MESONS. E.J.Sternglass.
Phys. Rev. (USA), Vol. 123, No. 1, 391-8 (July 1, 1961).

In an effort to obtain a semiclassical model for the neutral π-meson, a Bohr–Sommerfeld type of system with the proton replaced by a positron is investigated in the limit of high velocities. It is found that as a result of the relativistic increase in the electromagnetic field between the two moving charges, a natural minimum approach distance occurs equal to one-half of the classical "shell-electron" radius. At this separation, a new set of quantized states becomes possible which is found to be energetically unstable. The lowest state possesses an energy approximately equal to the π^0-meson energy. The relativistic states are characterized further by the greatly increased importance of perihelion precession, which accounts for one-half of the total angular momentum in the extreme relativistic case. When the effect of precession on the intrinsic magnetic moment is taken into account, the total energy of the system is found to be 263 m_0c^2, in close agreement with the observed π^0-meson mass. The lifetime of the system against annihilation into two gamma rays is calculated on the basis of the close analogy to singlet positronium. Its value is found to be 2.06×10^{-16} sec, in good agreement with the latest value of the observed π^0-meson lifetime. The implications for the structure of other nuclear particles and their interactions are briefly discussed.

10902 MEAN LIFETIME OF THE NEUTRAL PION. R.G.Glasser, N.Seeman and B.Stiller.
Phys. Rev. (USA), Vol. 123, No. 3, 1014-20 (Aug. 1, 1961).

An estimate of the mean lifetime of the π^0-meson was obtained from an experiment employing a direct time-of-flight technique first attempted by Harris et al. in 1957 (Abstr. 6604 of 1957). This method is based upon the observation in nuclear emulsion of the decay of the $K_{\pi 2}{}^+$ meson ($K^+ \rightarrow \pi^+ + \pi^0$) and the subsequent decay of the π^0 via the Dalitz mode, $\pi^0 \rightarrow e^+ + e^- + \gamma$. In the experiment the authors were able to utilize a new fine-grained emulsion (Ilford L.4) that yielded markedly improved resolution. The availability of the separated K^+ beam from the Bevatron at Berkeley permitted detection and measurement of 76 Dalitz decays. For the mean lifetime of the π^0 a value of $\tau = (1.9 \pm 0.5) \times 10^{-16}$ sec was obtained.

10903 PION PRODUCTION IN ELECTRON–POSITRON COLLISIONS. F.Chilton.
Phys. Rev. (USA), Vol. 123, No. 2, 656-6 (July 15, 1961).

The properties due to the presence of symmetries in pion production processes in electron–positron collisions are discussed. Cross-sections are calculated for the production reactions $e^+ + e^- \rightarrow \pi^0 + \gamma$, $e^+ + e^- \rightarrow e^+ + e^- + \pi^0$, and $e^+ + e^- \rightarrow \pi^+ + \pi^-$. The photon spectrum for the reaction $e^+ + e^- \rightarrow \pi^+ + \pi^- + \gamma$ is also calculated. The role of form factors and some of the possible effects of resonant strong interactions are discussed.

THE POSSIBILITY OF THERAPEUTIC APPLICATIONS OF BEAMS OF NEGATIVE π-MESONS. See Abstr. 10344

10904 EXTENSION OF THE ISOBARIC NUCLEON MODEL FOR PION PRODUCTION IN PION–NUCLEON, NUCLEON–NUCLEON, AND ANTINUCLEON–NUCLEON INTERACTIONS. R.M.Sternheimer and S.J.Lindenbaum.
Phys. Rev. (USA), Vol. 123, No. 1, 333-76 (July 1, 1961).

The isobaric nucleon model of pion production in nucleon–nucleon and pion–nucleon collisions (Abstr. 4776, 8190 of 1957; 2493 of 1958; 17403 of 1960) is extended to include the effect of the higher resonances in the isotopic spin $T = \frac{3}{2}$ state of the pion–nucleon system, in addition to the effect of the well-known low-

energy $T = \frac{3}{2}$ resonance which has been previously investigated. The higher $T = \frac{1}{2}$ resonances are centred at incident pion energies of 600 and 8800 MeV, and thus correspond to isobar masses $m_I = 1.51$ and 1.68 BeV, respectively, as compared to $m_I = 1.23$ BeV for the $T = \frac{1}{2}$ resonance. For the inelastic pion–nucleon interactions, calculations of the various pion and recoil nucleon energy spectra are carried out for incident pion energies $T_{\pi,\,inc} = 1.0$, 1.4, and 2.0 BeV. Both single and double pion production by the incident pion is considered, corresponding to two-pion and three-pion final states, respectively. General equations for the centre-of-mass energy spectra of the final-state pions and nucleons are obtained for all single and double pion production reactions from both π^-–p and π^+–p collisions. The results of the present extended isobar model at $T_{\pi,\,inc} = 1.0$ BeV are in reasonable agreement with the combined data from three experiments on π^-–p interactions in the region of 1.0 BeV incident energy. The Q-value distributions for pion–nucleon and pion–pion pairs are calculated for single pion production at $T_{\pi,\,inc} = 1.0$ BeV. The present extension of the isobar model can also be used to treat up to four-pion final states in π–N interactions, and up to eight-pion final states in N–N interactions. For pion production in nucleon–nucleon collisions, the branching ratios are obtained for all pion production reactions which involve the isobaric states N_1^*, N_{2a}^*, and N_{2b}^*, corresponding to the $T = \frac{3}{2}$ and $T = \frac{1}{2}$ resonances. General equations for the energy spectra of the final-state pions and nucleons are derived for all single- and double-pion production reactions from both p–p and n–p collisions. Calculations of the various pion and nucleon energy spectra are carried out for incident nucleon energies of 2.3 and 3.0 BeV. For the processes of pion production in antinucleon–nucleon interactions which do not result in annihilation, it is assumed that an anti-isobar $\bar{N}_\alpha^*$ can be produced, which is the antiparticle of the isobar N_α^*. Specific results are obtained for both single and double pion production in $\bar{p}$–p, $\bar{p}$–n, and $\bar{n}$–p collisions.

10905 PION PRODUCTION AND THE SECOND PION-NUCLEON RESONANCE.

C.J.Goebel and H.J.Schnitzer.

Phys. Rev. (USA), Vol. 123, No. 3, 1021-39 (Aug. 1, 1961).

A model for the reaction $\pi + N \rightarrow 2\pi + N$ at low energies, which includes pion–pion interaction and final-state interactions in the (3, 3) state, is discussed. The theory involves two parameters which are related to the S-wave and P-wave π–π scattering lengths. These parameters are chosen from a fit to the total cross-section for $\pi^- + p \rightarrow \pi^- + \pi^+ + n$. Meson production is predicted to be primarily in the $T = \frac{1}{2}$ state. Predictions are made for the total cross-sections of the various channels (e.g. $\pi^+ + p \rightarrow \pi^+ + \pi^+ + n$, etc.) in the energy range from threshold to $\cong$ 500 MeV in good agreement with experiments. Angular distributions are predicted. These are in qualitative agreement with the π^+ angular distribution for $\pi^- + p \rightarrow \pi^- + \pi^+ + n$. From these data it is suggested that the S-wave π–π scattering length has opposite sign to the P-wave scattering length. A conjecture concerning rapidly rising inelastic cross-sections in a single partial wave is made to connect the large $T = \frac{1}{2}$, $D_{3/2}$ production cross-sections with the $T = \frac{3}{2}$, $D_{3/2}$ pion–nucleon resonance. The π–π scattering lengths found are $a_0 = -0.290\,\mu^{-1}$, $a_1 = 0.122\,\mu^{-1}$, and $a_2/a_0 = \frac{2}{5}$ by hypothesis.

10906 THEORY OF SINGLE PION PRODUCTION IN PROTON–PROTON COLLISIONS.

J.Iizuka and A.Klein.

Phys. Rev. (USA), Vol. 123, No. 2, 669-77 (July 15, 1961).

Single pion production in nucleon–nucleon collisions in the BeV energy region is studied by means of the picture due to Weiszäcker–Williams (peripheral interaction model) and in the $(\frac{3}{2}, \frac{3}{2})$ resonance approximation for the final-state pion–nucleon interaction. The excitation curve for the reaction $p + p \rightarrow p + n + \pi^+$, nucleon momentum distributions, and Q-value distributions in the centre-of-mass system are calculated and compared with the published experimental data as well as with the work of Lindenbaum and Sternheimer (Abstr. 4776 of 1957). Agreement is reasonable with both, thus indicating that these particular distributions are insensitive to the isobar production mechanism (single-pion exchange), though more recent experiments seem to have indicated clearly a preference for the theory developed here.

10907 π^+–PROTON SCATTERING AT 990 MeV.

J.K.Kopp, A.M.Shapiro and A.R.Erwin.

Phys. Rev. (USA), Vol. 123, No. 1, 301-6 (July 1, 1961).

Positive-pion scattering at 990 ± 30 MeV was examined in a 6 × 3 × 2 in. hydrogen bubble chamber without a magnetic field. The cross-sections for elastic and inelastic scattering were found to b 15.3 ± 1.5 mb and 12.6 ± 3.3 mb, respectively. The inelastic scattering cross-section includes $0.19_{-0.07}^{+0.06}$ mb of Σ^+–K^+ production and 0.78 ± 0.14 mb of $\pi^+\pi^+\pi^-$ p production. A simple pion pion model which predicts the branching ratios for double pion pro duction in π^-–p collisions is found to be inconsistent with the dou pion production observed in this experiment. The relation of the experiment to π^-–p experiments in the region of the second and t resonances is discussed.

10908 NUCLEON–ANTINUCLEON MECHANISM FOR PION–PION SCATTERING RESONANCES.

J.G.Belinfante.

Phys. Rev. (USA), Vol. 123, No. 1, 306-7 (July 1, 1961).

The Chew–Mandelstam N/D equations for pion–pion scatterin (Abstr. 13019 of 1960) are modified to include contributions from the nucleon–antinucleon intermediate state, which is estimated in perturbation theory as well as by limitations imposed by unitarity alone. It is found that the Frazer resonance (Abstr. 11358 of 1959 could not be obtained by such a simple mechanism, starting from S-wave dominant solutions.

10909 TEST OF GLOBAL SYMMETRY IN PION–BARYON INTERACTIONS BY K^- + p REACTIONS. J.C.Pati.

Phys. Rev. (USA), Vol. 123, No. 2, 705-10 (July 15, 1961).

Under the hypothesis that the K-meson interactions do not ma the symmetries of the pion–baryon interactions appreciably, the branching ratios of the K^- + p reaction are studied to test the validity of global symmetry. The T^{-1}-matrix formalism of Matthe and Salam is adopted to calculate the branching ratios. The new Dalitz–Tuan solutions for KN scattering lengths, which incorporat the (K^+, K^0) mass difference and the branching ratios of the variou K^- + p reactions, presented at Kiev, are adopted in the analysis. The errors in the experimental branching ratios are so chosen as to satisfy the Amati–Vitale inequality. It is found that the a^- and b^+ (also a^+, though poorly) Dalitz–Tuan solutions can explain the branching ratios for K^- captures at rest. The extension of the analysis to 30 MeV incident K^- mesons under the zero-range approximation leads to very poor agreement with experiments.

10910 CORRELATIONS BETWEEN CUSPS IN DIFFERENTIAL CROSS SECTIONS AND IN POLARIZATIONS.

M.Nauenberg and A.Pais.

Phys. Rev. (USA), Vol. 123, No. 3, 1058-65 (Aug. 1, 1961).

Experiments have shown that partial waves with $l > 1$ appear $\pi^- + p \rightarrow \Lambda + K^0$ at the ΣK thresholds. This necessitates a recon-sideration of the criteria sufficient to determine the $\Sigma\Lambda$ parity $P(\Sigma\Lambda)$ by the method of cusps. The authors start from the usual assumption that contributions which show a cusp in either the diff ential cross-section or the polarization may be ignored beyond so optimal power in $\cos\theta$. On this sole basis, previously stated crite are rendered inadequate due to the occurrence of Minami and othe ambiguities. It is shown that under suitable circumstances there exist unambiguous correlations between certain properties of cro section cusps and of polarization cusps. These correlations could possibly be of use to determine $P(\Sigma\Lambda)$ and give information as to which states contribute significantly to the ΛK production at $\sim$ 900 MeV. The finite separation between Σ^0K^0 and Σ^-K^+ thresh is taken into account. The results are summarized in a table of cusp properties.

10911 ON THE TEST OF GLOBAL SYMMETRY.

S.Furui and T.Sakuma.

Progr. theor. Phys. (Japan), Vol. 24, No. 1, 18-26 (July, 1960).

An attempt to investigate the concept of global symmetry on t strong interactions in the pion–baryon system is presented. To this end, the absorption processes of K^--mesons by protons are i vestigated at low energies. The general relations of complex phases in K^-–p absorption are also presented. Fairly conclusive evidence for inconsistency of global symmetry with present exper ments is obtained. The effects of the intermediate $\bar{K}$–N states an Λ states are also discussed. It should be noted that this conclusi is derived only by kinematical considerations and not by details o dynamics in the model.

10912 P-WAVE PION–PION INTERACTION.

Y.Miyamoto.

Progr. theor. Phys. (Japan), Vol. 24, No. 4, 840-50 (Oct., 1960).

The P-wave pion–pion resonance formula is derived by both the Chew–Mandelstam theory (Abstr. 13019 of 1960) and the chain approximation. Adopting the scattering length $a = \frac{1}{3}(\hbar/\mu c)^3$, the author predicts the resonance of 600 MeV and total width of 130 Me

hich is consistent with the results of Takeda et al. (1960) and ulco and Frazer (Abstr. 11358 of 1959; 7341 of 1960). The mean quare radius of the isovector part of the magnetic moment of a ucleon is calculated by using the chain approximation.

10913 SINGLE PION PRODUCTION PROCESS IN PION–NUCLEON COLLISION AND THE SAKATA MODEL. S.Sawada.
Progr. theor. Phys. (Japan), Vol. 25, No. 1, 83-101 (Jan., 1961).

Based on the Sakata model (Abstr. 6884 of 1957) the author proposes a model for the single-pion production process in π–N collisions which is essentially an extension of the Lindenbaum–Sternheimer model (Abstr. 2493 of 1958). It is pointed out that the analyses of sub-BeV single-pion production phenomena will provide useful information about the level scheme of the Sakata model. As a first step of the investigation of this model an analysis of the single-pion production process in π^+–p collision at 500 MeV is made. The model predicts the contribution of the I = 2 boson isobar as well as the I = $\frac{3}{2}$ fermion isobar (Lindenbaum–Sternheimer model) for this process. Such a prediction is consistent with the present experimental branching ratio

$$(\pi^+ + p \to \pi^+ + \pi^0 + p)/(\pi^+ + p \to \pi^+ + \pi^+ + n) = 1.5.$$

The author calculates the energy and angular distribution of the pion and nucleon which will be useful for obtaining information about the I = 2 boson isobar and I = $\frac{3}{2}$ fermion isobar from this process.

10914 LOW-ENERGY PION–PION S-WAVE PHASE SHIFTS. B.P.Desai.
Phys. Rev. Letters (USA), Vol. 6, No. 9, 497-500 (May 1, 1961).

At the symmetry point, the two s-wave amplitudes and their first and second derivatives are related to the pion–pion coupling constant, the p-wave amplitude and its derivative at this point. Using a two-parameter resonance form for the p-wave amplitude, and replacing the left-hand cut of the s-wave dispersion relations by single poles, the author is able to relate the positions and residues of the latter to the parameter of the p-wave resonance and the pion–pion coupling constant. With the Frazer–Fulco form for the p-wave resonance and a suitable value of λ, it is possible to fit the enhancement factor, due to final-state interaction, for the process $p + d \to He^3 + \pi^+ + \pi^-$. E.J.Squires

10915 PION–NUCLEON INTERACTION IN THE REGION OF THE HIGHER RESONANCES. P.Carruthers.
Phys. Rev. Letters (USA), Vol. 6, No. 10, 567-70 (May 15, 1961).

The reactions $\pi^- + p \to \pi^- + \pi^+ + n$, $\pi^- + p \to \pi^- + \pi^0 + p$ are discussed for pion energies around 1 BeV. The inadequacy of the one-pion exchange model, even when final-state pion–nucleon interactions are included, to describe the results on the second reaction is pointed out. An explanation of the third resonance, as being caused essentially by the final-state interaction of a single pion with the nucleon, together with the effects of Bose statistics, is given. E.J.Squires

EMISSION OF Li^8, Li^9 AND B^8 FRAGMENTS FROM STARS PRODUCED BY 4.3 GeV π^--MESONS IN NUCLEAR EMULSION. See Abstr. 11028

10916 ISOBAR MODEL AND THE S-WAVE PION–NUCLEON SCATTERING. Y.Fujii.
Prog. theor. Phys. (Japan), Vol. 24, No. 5, 1013-32 (Nov., 1960).

For the scattering lengths of the S-wave pion–nucleon scattering, Chew et al. (Abstr. 7428 of 1957) have shown that the result of their dispersion relation without subtraction gives excellent agreement with the observations, as long as the integrations are carried out over the 3-3 resonance alone. Correspondence of their result to the Hamiltonian formalism is examined by replacing the 3-3 resonant state by an isobaric particle of spin $\frac{3}{2}$, which is described by the Rarita–Schwinger theory (1941). The scattering amplitudes are calculated by means of the lowest-order perturbation theory. By requiring further that the amplitudes should decrease to zero in the high energy limit, it is found necessary to introduce the interaction terms other than the conventional one. These terms are left undetermined from the location and the width of the 3-3 resonance. By an appropriate choice of the parameters involved in these terms, the result of Chew et al. can be reproduced in the narrow-width approximation.

10917 SOME CONSIDERATIONS ON THE LOW-ENERGY PION–NUCLEON SCATTERING. K.Ishida.
Progr. theor. Phys. (Japan), Vol. 24, No. 5, 980-90 (Nov., 1960).

The unsubtracted dispersion relations of Chew et al. (Abstr. 7428 of 1957) are reinterpreted as the approximate equations for low-energy pion–nucleon scattering with the additional function only of invariant momentum transfer (κ^2), in which the effect of the pion–pion interaction is partially included. Using this reinterpreted unsubtracted dispersion relation, the author discusses the effect of the pion–pion interaction on pion–nucleon scattering, and the unsubtracted dispersion relations of Goldberger et al. (Abstr. 8509 of 1955) for forward pion–nucleon scattering in the laboratory system.

10918 ON THE SEMI-CLASSICAL TREATMENTS OF THE MESON–NUCLEON SCATTERING. S.Ishida.
Progr. theor. Phys. (Japan), Vol. 24, No. 6, 1166-78 (Dec., 1960).

A quantum mechanical treatment of static meson–nucleon scattering is presented which has close connection with the semi-classical theory. On this basis the semi-classical treatments of the p-wave pion–nucleon scattering recently developed independently by Jackson (The Physics of Elementary Particles. Princeton, New Jersey: Princeton University Press, 1958, Part 1, Chap. 3) and by Weisskopf (Abstr. 3985 of 1960) are examined. As a result it is shown that their treatments are not complete and that, if treated correctly, their effective-range formula should be modified largely. This would result in a deviation from the experimental behaviour. Applications to the charged and neutral scalar theories are also given and compared with the Castillejo–Dalitz–Dyson theory. (Abstr. 2676 of 1956).

10919 PION–NUCLEON SCATTERING AND PION–PION INTERACTION. S.Ishida.
Progr. theor. Phys. (Japan), Vol. 24, No. 6, 1262-74 (Dec., 1960).

S-wave pion–nucleon scattering is investigated on the assumption that pion–pion interaction is important. Starting from the interaction Lagrangian L_I

$$-L_I = \frac{G^2}{2M}\int \rho_C(r)\phi^2(\vec{r})d^3\vec{r} + \left(\frac{G}{2M}\right)^2 \tau \cdot \int \rho_C(r)\phi(\vec{r}) \times \dot{\phi}(\vec{r})d^3\vec{r} + V(0)\int \rho_\pi(r)\phi^2(\vec{r})d^3\vec{r},$$

(where the third term corresponds to the effective potential obtained from the original pion–pion interaction $H_I^{\pi-\pi} = \lambda(\phi\cdot\phi)^2$) the author solves directly the Klein–Gordon equations on the matrix elements of the meson field operator between the nucleon state and the nucleon plus one-meson state. Choosing Yukawa type for the form factors $\rho_1(r) = (4\pi r)^{-1}\Lambda_1^2 \exp[-\Lambda_1 r]$, one can obtain the best fit to the experimental behaviour of the S-wave phase shifts for the following value of the parameters: $\Lambda_C \cong 5\mu$, $\Lambda_\pi \cong 3.5\mu$, $(2/4\pi)[G^2/2M + V(0)] = (2/4\pi)(G^2/2M)(2/10)$ to $0 = (0.4 \text{ to } 0)\mu^{-1}$. This choice of V(0) corresponds to the original pion–pion coupling constant $\lambda/4\pi = 0.3$–0.5 and is consistent with the value $|\lambda|/4\pi \cong 1$ determined from the $(\pi, 2\pi)$ process at 1.4 BeV. On the basis as obtained above, the qualitative nature of the small P-wave phase shifts is discussed. Results are obtained which coincide with the ones of the analysis by Lomon and Chiu (Abstr. 4938 of 1959).

10920 COLLECTIVE CORRELATION BETWEEN VACUUM NUCLEONS AND THE S-WAVE PION–NUCLEON SCATTERING. O.Hara.
Progr. theor. Phys. (Japan), Vol. 24, No. 3, 495-511 (Sept., 1960).

The scattering of S-wave pions by nucleons is calculated taking into account the collective correlation between vacuum nucleons. A strong collective correlation can exist between vacuum nucleons just as between electrons in metal at the absolute zero of temperature, since interaction between vacuum nucleons due to pions is dominantly attractive. The effect of this correlation is calculated using Bogolyubov's method (Abstr. 7034 of 1958). The phase shift δ_3 is calculated using the Tamm–Dancoff approximation including up to two pions and one nucleon pair. It is shown that by taking this effect into account, the result of Dyson et al. (Abstr. 10806 of 1954) using the same approximation is improved greatly, and an overall agreement with experiment is obtained. δ_1 is not calculated in this paper.

10921 π^-–p ELASTIC SCATTERING AT 550, 600, 720, 900 AND 1020 MeV. C.D.Wood, T.J.Devlin, J.A.Helland, M.J.Longo, B.J.Moyer and V.Perez-Mendez.
Phys. Rev. Letters (USA), Vol. 6, No. 9, 481-4 (May 1, 1961).

Presents the results of measurements of differential cross-sections in the region of the second and third peaks in the π^-–p total scattering cross-section. S.J.St-Lorant

10922 DECAY PROPERTIES OF K_2^0 MESONS. D.Neagu, E.O.Okonov, N.I.Petrov, A.M.Rosanova and V.A.Rusakov.
Phys. Rev. Letters (USA), Vol. 6, No. 10, 552-3 (May 15, 1961).

More than 500 V^0 events were recorded in a magnet cloud chamber, of which 225 were measured completely. From the passage of the charged products through a 5.8 g cm^{-2} lead plate, the K_{e3}^0 decay mode was deduced to be 42 ± 12% of all decays with charged products. In decays with emission of charged pions, the ratio of negative to positive pions was 0.90 ± 0.18. There were no cases of $K_2^0 \to \pi^- + \pi^+$, and an upper limit for the relative probability of this decay can now be set at 0.3%. One four-pronged event was found which could be identified with the decay $K_2^0 \to \pi^- + \pi^+ + \pi^0$, there being a Dalitz pair from the π^0 decay. Four electron– positron pairs with comparatively large opening angles were found and concluded to be Dalitz pairs from $K_2^0 \to 3\pi^0$ decay. A.Ashmore

10923 PROPOSED METHOD OF MEASURING THE SPIN OF THE K' MESON. M.Schwartz.
Phys. Rev. Letters (USA), Vol. 6, No. 10, 556-7 (May 15, 1961).

It is shown that observation of the decay modes of the K^0 and $\overline{K^0}$ produced through $p + \bar{p} \to K^0 + \overline{K^0}$ and $\overline{K^0} \to K^0 + \pi^0$, where the capture takes place at rest, leads to a determination of the spin of the K'. E.J.Squires

10924 RESONANCE MODEL OF $\Lambda - K^0$ PRODUCTION. A.Kanazawa.
Phys. Rev. (USA), Vol. 123, No. 3, 997-1002 (Aug. 1, 1961).

A resonance model is proposed to explain the excitation function, the angular distribution, and the large polarization of Λ in the reaction $\rho+\pi^- \to \Lambda + K^0$. It is assumed that there exists a low angular momentum resonance in the channel $\rho+\pi^- \to$ (resonant state) $\to \Lambda + K^0$. There are five real parameters in this model. Two of these are the coupling constants of the usual interactions. The other three are the position, half-width, and height of the assumed resonance. With reasonable choices of parameters a fairly good fit is obtained, for both a scalar and a pseudoscalar K-meson, to the experimental data in the interval 910 to 1300 MeV of the pion kinetic energy in the laboratory system.

10925 PHOTOPRODUCTION OF K^+ MESONS FROM DEUTERIUM.
R.L.Anderson, F.Turkot and W.M.Woodward.
Phys. Rev. (USA), Vol. 123, No. 3, 1003-4 (Aug. 1, 1961).

The differential cross-section for the reaction $\gamma + n \to K^+ + \Sigma^-$ was measured. The data are obtained by observing the charged K-particle with a magnet spectrometer alternately from hydrogen and from deuterium. For γ-ray energy of 1122 MeV and for θ (c.m.) = 82° $d\sigma(n\Sigma^-)/d\sigma(p\Sigma^0) = 1.6 \pm 0.7$.

10926 INTERACTIONS OF 1.16 GeV/c K^- IN NUCLEAR EMULSIONS. M.Baldo-Ceolin, A.Caforio, F.Farini, A.Ferilli and G.Miari.
Nuovo Cimento (Italy), Vol. 19, No. 3, 597-9 (Feb. 1, 1961).

An Ilford G-5 emulsion was exposed beyond a hydrogen bubble chamber in the seperated K^- beam of the betatron. The pion contamination was estimated from the mean free path for nuclear interactions. Of the 225 interactions observed 70% are estimated to be due to K^-. They are analysed according to unstable secondaries. A.Ashmore

10927 K^-–p AND K^-–n CROSS SECTIONS IN THE MOMENTUM RANGE 1-4 BeV/c.
V.Cook, B.Cork, T.F.Hoang, D.Keefe, L.T.Kerth, W.A.Wenzel and T.F.Zipf.
Phys. Rev. (USA), Vol. 123, No. 1, 320-32 (July 1, 1961).

The energy dependence of the K^-–nucleon total cross-sections was measured over the K^- momentum range 0.98-3.98 BeV/c. K^-–n cross-sections were obtained by deuterium-hydrogen subtraction, with a correction for screening effects. There is evidence for structure in the T = 0 K^-–nucleon state in the momentum range 0.98-2.0 BeV/c. This structure is absent in the T = 1 state. In addition, a measurement was made at 1.95 BeV/c of the angular distribution of the K^-–p elastic scattering at small angles. The forward-scattering amplitude obtained from the data gives a ratio of real part to imaginary part 0.5 ± 0.2 at 0°. The corresponding ratio for π^- mesons at this momentum was found to be $0.4_{-0.4}^{+0.2}$. Measurements of the K^-–p "elastic" charge exchange gives a cross-section which falls from about 10 mb at 1 BeV/c to at most a few mb at 4 BeV/c.

10928 LOW-ENERGY $\bar{K}$–NUCLEON INTERACTION. R.C.King, R.E.Lanou, Jr and S.F.Tuan.
Phys. Rev. Letters (USA), Vol. 6, No. 9, 500-4 (May 1, 1961).

It is shown that present experimental data does not significantly favour either the (a+) or (a–) scattering length solutions for $\bar{K}$–nucleon scattering. E.J.Squires

10929 LONGE-RANGE INTERACTION IN $\bar{K}$–NUCLEON AND K–NUCLEON ELASTIC AMPLITUDES.
F.Ferrari, G.Frye and M.Pusterla.
Phys. Rev. (USA), Vol. 123, No. 1, 308-14 (July 1, 1961).

A method of calculating, for the K–nucleon interaction, the long range force arising from the exchange of a pion pair and of a possible three-pion resonant state is formulated. It is shown that long-range force can be related with the electromagnetic structure parameters of the nucleon and K-meson. Finally, relations between K–nucleon and $\bar{K}$–nucleon elastic amplitudes are discussed.

10930 ENERGY DEPENDENCE OF THE LOW-ENERGY K^-–PROTON AND K^+–PROTON CROSS SECTIONS.
F.Ferrari, G.Frye and M.Pusterla.
Phys. Rev. (USA), Vol. 123, No. 1, 315-20 (July 1, 1961).

The K^-–proton and K^+–proton S-wave scattering is analysed using a relativistic effective-range formula derived by studying the analytic properties of partial-wave scattering amplitudes. The influence of the pion–pion interaction on the elastic scattering and reaction cross-sections is discussed.

Hyperons

10931 BARYON PARITY AND POLARIZATION EXPERIMENT. K.Nakayama.
Progr. theor. Phys. (Japan), Vol. 24, No. 5, 953-62 (Nov., 1960).

Possible polarization experiments from which information about baryon parity can be gained are investigated using the reactions

$$\Sigma^- + p \to \Lambda^0 + n,$$

$$\Xi^- + p \to (\Lambda^0 + \Lambda^0), (\Sigma^0 + \Lambda^0), (\Sigma^+ + \Sigma^-),$$

and

$$\Xi^- + He^4 \to {}_\Lambda H^4 + \Lambda^0.$$

In these experiments, the transversely polarized hyperon beam would be scattered on the unpolarized target, p or He^4, and useful information would be obtainable by measuring the transverse components of polarization of the final products. All these experiments appear to be possible in the near future.

10932 PION–LAMBDA RESONANCE (Y_1^*).
J.P.Berge, P.Bastien, O.Dahl, M.Ferro-Luzzi, J.Kirz, D.H.Miller, J.J.Murray, A.H.Rosenfeld, R.D.Tripp and M.B.Watson
Phys. Rev. Letters (USA), Vol. 6, No. 10, 557-62 (May 15, 1961).

Experimental results on the production and decay of Y_1^* resonances in $K^- + p \to \Lambda + \pi^+ + \pi^-$ processes, for K momenta from threshold (405 MeV/c) to 850 MeV/c, are presented and discussed. The results are inconsistent with the decay of an isolated Y*, i.e., final-state interactions and statistics are important, and this makes interpretation difficult. A mass of 1385 MeV and half-life of about 20 MeV fit the resonance curve. The results are consistent either with a "global symmetry" type resonance ($J = \frac{3}{2}$) or with a Dalitz–Tuan s-wave K^-–p resonance ($J = \frac{3}{2}$). E.J.Squires

10933 BOSE STATISTICS AND Y* PRODUCTION AND DECAY IN K^-–p COLLISIONS. R.H.Dalitz and D.H.Miller.
Phys. Rev. Letters (USA), Vol. 6, No. 10, 562-7 (May 15, 1961).

It is shown that symmetrizing with respect to the two pions has an appreciable effect on the energy and angular distributions in the process $K^- + p \to Y^{\pm} + \pi^{\mp} \to \Lambda + \pi^+ + \pi^-$. This makes it difficult to distinguish between $J = \frac{1}{2}$, $J = \frac{3}{2}$ assignments for the Y spin, although this should be possible with experiments at higher K energies. E.J.Squires

10934 $\Delta I = \frac{1}{2}$ RULE IN Σ DECAY: A PROBLEM OF SIGN. S.P.Rosen.
Phys. Rev. Letters (USA), Vol. 6, No. 9, 504-5 (May 1, 1961).

It is pointed out that certain admixtures of $\Delta I = \frac{1}{2}, \frac{3}{2}$ and $\frac{5}{2}$ can give the same physical consequences in Σ decay as pure $\Delta I = \frac{1}{2}$. E.J.Squires

euterons

DEUTERON PROPERTIES COMPUTED FOR DIFFERENT TENTIALS. See Abstr. 10889

DEUTERONOMY. SYNTHESIS OF DEUTERONS AND THE GHT NUCLEI DURING THE EARLY HISTORY OF THE SOLAR STEM. See Abstr. 10373

10935 PHOTODISINTEGRATION OF THE DEUTERON IN MEDIUM ENERGY RANGE AND THE PION THEORETAL NUCLEAR FORCES.
Iwadare and M.Matsumoto.
rogr. theor. Phys. (Japan), Vol. 24, No. 4, 797-816 (Oct., 1960).

The static pion potential which consists of the central and tensor urts is applied to the calculation of the photodisintegration of the euteron in the medium-energy range (20-80 MeV). The angular stributions are in good agreement with the observed results. he polarizations of the final proton and neutron are also calculated. o experimental observation is available for comparison. The eneral formulae are given for the angular distribution and polariztion with the numerical coefficients for the lower multipole ansitions.

DEUTERIUM (n,2n) CROSS-SECTIONS BETWEEN 6 AND 0 MeV. See Abstr. 11023

COSMIC RAYS

(Nuclear reactions due to cosmic rays are included under Nuclear Reactions)

10936 DELAYED PROPAGATION OF SOLAR COSMIC RAYS ON SEPTEMBER 3, 1960.
.R.Winckler, P.D.Bhavsar, A.J.Masley and T.C.May.
hys. Rev. Letters (USA), Vol. 6, No. 9, 488-91 (May 1, 1961).

Observations are reported of a flare event in which the osmic-ray increase was delayed by several hours. Observations ere made with ionization chambers, Geiger counters, and nuclear mulsions flown in balloons at two different latitudes, and are ompared with sea-level neutron measurements. The flare which s believed to have caused the cosmic-ray emission was preceded y two other class 3 flares, and it is suggested that the delay in ransit of the cosmic rays was produced by interaction with solar louds produced in the previous flares. Time delays were largest or the low-energy detectors and smallest for the high-energy letectors. N.A.Porter

10937 ROCKET OBSERVATIONS OF SOLAR PROTONS ON SEPTEMBER 3, 1960.
L.R.Davis, C.E.Fichtel, D.E.Guss and K.W.Ogilvie.
Phys. Rev. Letters (USA), Vol. 6, No. 9, 492-4 (May 1, 1961).

Measurements of the energy spectrum of protons in the range 13 to 250 MeV were made with Geiger counters, using variable absorber thickness, and with nuclear emulsions. Two rockets were fired shortly after the onset of the solar flare. Good agreement was obtained between counter and emulsion measurements, and the results are consisted with the delay mechanism suggested by Winckler et al. (see preceding abstract). N.A.Porter

10938 HEAVY NUCLEI IN SOLAR COSMIC RAYS.
C.E.Fichtel and D.E.Guss.
Phys. Rev. Letters (USA), Vol. 6, No. 9, 495-7 (May 1, 1961).

The analysis of emulsion flown in a rocket during the solar particle event of September 3, 1960 has yielded the proportion of medium nuclei ($6 \leq Z \leq 8$) to protons in solar cosmic rays. The tracks in the emulsion due to heavy particles (after the elimination of slow α-particles) fell into two groups with residual ranges: (1) of the order of several millimetres or less, (2) of the order of several centimetres or more. Evidence is presented for the belief that the latter group belong to the galactic cosmic rays and hence that the first group are of solar origin. The charges of the particles of the first group were measured by comparing the relation between δ-ray density and residual range with Mott's formula. Knowing the charge and range their rigidities were then calculated. The flux found was 20 ± 4 particles m^{-2} sr^{-1} sec^{-1}, with rigidities > 570 MeV/c and $6 \leq Z \leq 8$. The flux of protons with rigidities >570 MeV/c is $(2.5 \pm 0.7) \times 10^4$ and the ratio of these fluxes is $(0.8 \pm 0.3) \times 10^{-3}$. This ratio is near the ratio of medium nuclei to protons in the sun ($1\text{-}2 \times 10^{-3}$) but an order of magnitude less than the same ratio in the galactic cosmic rays ($9.3 \pm 0.7 \times 10^{-3}$). Evidence is presented to show that the relative abundance of the medium nuclei is much the same as their relative abundance in the sun. J.L.Redding

10939 MEASUREMENTS OF RADIATION DURING THE FLIGHT OF THE THIRD COSMIC ROCKET.
S.N.Vernov, A.E.Chudakov, P.V.Vakulov, E.V.Gorchakov, Yu.I.Logachev and A.G.Nikolaev.
Dokl. Akad. Nauk SSSR, Vol. 136, No. 2, 322-4 (Jan. 11, 1961). In Russian.

For abstract, see Abstr. 4815 of 1961. [English translation in: Soviet Physics—Doklady (USA), Vol. 6, No. 1, 43-5 (July, 1961)].

10940 ISOTOPIC COMPOSITION OF THE LOW-ENERGY HELIUM NUCLEI IN THE PRIMARY COSMIC RADIATION. M.V.K.Appa Rao.
Phys. Rev. (USA), Vol. 123, No. 1, 295-300 (July 1, 1961).

The isotopic composition of low-energy helium nuclei was determined by using the "constant sagitta" scattering method on tracks of helium nuclei stopping in a nuclear-emulsion stack flown at a geomagnetic latitude $\lambda = 55^0$ N and at a mean atmospheric depth of 8.5 g cm^{-2}; tracks with zenith angles less than 30^0 were accepted. The ratio of $He^3/(He^3 + He^4)$ for the same energy per nucleon (between 200 and 400 MeV) was found to be 0.41 ± 0.09 at flight altitude. The correction for production of secondary He^3 in the residual atmosphere is calculated to be 4%. If one assumes that no He^3 nuclei are present at the source, the observed ratio corresponds to a traversal of 14 ± 3 g of interstellar matter by the low-energy helium nuclei. The value of $He^3/(He^3 + He^4)$ corresponding to the same magnetic rigidity (between 1.3 and 1.6 BV) is found to be 0.36 ± 0.11 which corresponds to a traversal of 12.2 ± 3.5 g of interstellar matter. The observed ratio may indicate the presence of He^3 at the source of cosmic rays, or may be a reflection of local production within the solar system.

ANALYSIS OF HIGH-ENERGY JET SHOWERS. See Abstr. 10883

10941 ON THE HIGH ENERGY SOFT COMPONENTS AT 2770 m ALTITUDE. T.Kameda and T.Maeda.
J. Phys. Soc. Japan, Vol. 15, No. 8, 1367-72 (Aug., 1960).

An apparatus consisting of GM-counter hodoscopes and an ionization chamber with a large area was used to measure cascade showers initiated by electrons and photons at 2770 m altitude (Mt. Norikura). The number of shower particles deduced from the pulse height of the ionization chamber was converted into energy of the electron (or photon) initiating the shower. The results show that, in the energy range of 2–20 BeV, (i) the zenith angle distribution of electrons is represented by $\cos^5 \theta$, (ii) the differential energy spectra can be represented by a power law of the form $E^{-\gamma}$ with γ of 2.90 ± 0.05 and 2.83 ± 0.05 for electrons and photons respectively, and (iii) the upper limit of the ratio of the number of electrons to that of photons is 1.1 ± 0.1. The present results are compared with those obtained near sea level and the origin of the soft component is also discussed.

10942 ON THE STRUCTURE OF EXTENSIVE AIR SHOWERS. II. A.Ueda.
Progr. theor. Phys. (Japan), Vol. 24, No. 6, 1231-61 (Dec., 1960).

For Pt I, see Abstr. 11265 of 1960. The structure of extensive air showers (EAS) is examined in detail, in particular its dependence upon the characteristics of the high-energy nuclear interactions and primary energy spectrum. The following effects are taken into account: (1) the fluctuation in the depth at which the primary particles make their first interaction; (2) the fluctuations in the first interaction made by heavy primary particles. The main results are summarized as follows. (a) Shower curves are derived which are consistent with experiments, by a proper choice of the parameters involved in this model of the high-energy interaction. (b) Under the assumptions that the relative abundance of various groups of primary nuclei at the top of the atmosphere is the same as measured at lower energies and that all groups have the same energy spectra as the proton spectrum, the calculated shower size spectrum is not inconsistent with that observed even if there is a cutoff in the primary energy at about 5×10^6 Mc^2 per nucleon. (c) Under the same assumptions, the fluctuation in the

ratio between numbers of muons and of electrons is, at sea level, almost entirely governed by the fluctuation in the depth of the first interaction of protons. At mountain altitudes the fluctuation in the ratio is governed nearly equally by both the fluctuations due to protons and by those due to heavy nuclei. (d) Under the same assumptions, the shower rate due to primary nuclei heavier than protons is, at mountain altitude, equal to or greater than twice that due to protons. (e) There is a possibility that high-energy nuclear active particles ($> \sim 10^{12}$ eV) in EAS initiated by a proton are as abundant as those in an EAS initiated by a heavy nucleus. Additional remarks which would be useful for further investigations are given.

10943 ANGULAR DISTRIBUTION OF SHOWER PARTICLES FROM 1000 BeV [PER] NUCLEON ALPHA PARTICLES ON EMULSION NUCLEI. P.L.Jain.
Phys. Rev. (USA), Vol. 122, No. 6, 1890-6 (June 15, 1961).

Twenty-eight interactions of α-particles were located in a 22 litre stack of nuclear emulsion by tracing back showers of minimum ionization particles to their origins. The angular distributions of 17 α-particles with a dip angle $\leq 20^0$ are presented. The inelasticity for these 17 interactions shows large fluctuations for individual events and its mean value is 30%. The angular distributions of these α-particles were transferred into a system in which they are roughly symmetric. The degree of anisotropy of the angular distributions is in disagreement with a hydrodynamical model of nucleon–nucleus collisions. The detailed analysis of the angular distribution of composite stars for events with a high degree of anisotropy of secondaries in the centre-of-mass system shows that the shape of the angular distribution is in agreement with the predictions of the "two-fireball" model of multiple meson production, both for nucleon–nucleon and nucleon–nucleus collisons.

10944 EXTREMELY ENERGETIC COSMIC-RAY EVENT. J.Linsley, L.Scarsi and B.Rossi.
Phys. Rev. Letters (USA), Vol. 6, No. 9, 485-7 (May 1, 1961).

Preliminary report of a large extensive air shower, observed with an array of scintillation counters covering an area of 2 km^2, at altitude 5800 ft. The size was derived as 5.5×10^9 particles, using a lateral distribution function found for smaller showers, and is probably under-estimated. The primary energy is estimated to be at least 10^{19} eV, corresponding, for a proton, to a radius of curvature in the galaxy of 10^4 light years. The proportion of penetrating particles was normal. Arrival times of particles at distant detectors imply a shower radius greater than 7 km, but delayed particles were observed up to 4 μsec late. It is concluded that the primary particle acquired its energy outside the galaxy. N.A.Porter

10945 THE COSMIC RAY OBSERVATIONS OF DECEMBER 4, 1957. B.G.Wilson.
Nature (GB), Vol. 190, 615-16 (May 13, 1961).

It is suggested that the increase in the total component of the cosmic radiation at Paris on December 4, 1957, reported by Legrand and Helary (Abstr. 17448 of 1960) is not associated with an injection of solar protons. This suggestion is based on an analysis of the records of the total, hard and nucleonic components of the cosmic radiation measured at Banff, Canada, at the time, which show no unusual variation. Further Collins and Jelley (Abstr. 6606 of 1961) report that ionospheric conditions were normal at the time, and the maximum at Paris occurred about 6 hours later than the optical flare (importance 1) on the same day. Hence it is difficult to reconcile the event with the pattern of development of cosmic ray flares. J.L.Redding

10946 PHOTOSTAR CROSS-SECTION FROM COULOMB DISINTEGRATIONS OF HIGH ENERGY HEAVY PRIMARIES. S.T.Butler and C.A.Pearson.
Nuovo Cimento (Italy), Vol. 19, No. 6, 1266-8 (March 16, 1961).

The variations in the cross-section for Coulomb disintegration are presented as a function of the mass of the nucleus and of the primary energy. S.J.St-Lorant

10947 STANDARD ERRORS AT HARMONIC ANALYSIS ON COSMIC RAY DATA. E.Dyring and B.Rosén.
Tellus (Sweden), Vol. 13, No. 1, 113-18 (Feb., 1961).

Errors were calculated by three different methods. These methods are discussed and numerical calculations are carried out using the results of harmonic analyses made on data from the neutron monitors in Uppsala and Murchison Bay. Periods covering from single days up to the mean of three years were used for the comparison between the results. Although the standard error calculated according to the three methods includes different types of variations, the results show good similarity. One of the meth also gives indications that only in some cases the addition of a second harmonic will be an improvement.

NUCLEUS

10948 COULOMB BARRIER IN A HIGHLY EXCITED NUCL D.W.Lang.
Phys. Rev. (USA), Vol. 123, No. 1, 265-6 (July 1, 1961).

Experiments involving alpha emission spectra from nickel a rhodium bombarded with protons are analysed using the statistic model. It is shown, using values calculated by Igo (Abstr. 1419 1960) for the cross-sections for alpha absorption, that the exper mental data are consistent with a constant value for the potentia barrier.

10949 TRANSFORMATION BRACKETS FOR HARMONIC-OSCILLATOR STATES. B.J.Verhaar.
Physica (Netherlands), Vol. 26, No. 12, 1045-6 (Dec., 1960).

The transformation between two-particle, and centre-of-ma and relative harmonic oscillator states is related to fractional parentage coefficients in the U_3 classification. J.Golds

10950 THEORY OF FINITE NUCLEI IN STATISTICAL METHOD WITH CORRELATION CORRECTION. I. Y.Hara.
Progr. theor. Phys. (Japan), Vol. 24, No. 6, 1179-94 (Dec., 1960)

A statistical method is developed, in which the effective potential is the density-dependent nonlocal reaction matrix in th nuclear matter. This method is applied to the calculation of the surface thickness, t, and the surface energy, E_S, of heavy nuclei and the following results are obtained: $t = (2.8\text{-}3.0) \times 10^{-13}$ cm, where t is the 90% to 10% distance, and $E_S = (23\text{-}28)A^{2/3}$ MeV.

10951 NUCLEAR DEFORMATION AND NUCLEAR FORCE. S.Nagata.
Progr. theor. Phys. (Japan), Vol. 25, No. 1, 35-50 (Jan., 1961).

The magnitude of nuclear deformation is determined by the variational method in the case of rotational light nuclei. The Hamiltonian used is essentially the same as that of Brueckner's shell model space (Abstr. 2515 of 1958), where the reaction mat is calculated from the Gammel–Thaler potential. The deformed potential model wave-function is taken as a trial wave-function, where the deformation parameter and the internucleon distance taken as variational parameters. The central force gives the eq rium deformation of the same order as experimental value for s configurations in the case of Mg^{24}. The results are discussed.

10952 NUCLEAR DEFORMATION AND NUCLEAR FORCE. K.Ikeda, S.Nagata and K.Takada.
Progr. theor. Phys. (Japan), Vol. 25, No. 1, 51-63 (Jan., 1961).

In Pt I, a calculation was carried out for the central part of reaction matrix in the case of Mg^{24}; here the same computation performed for the tensor and spin–orbit part. Putting the resul of the present calculation and the previous one together, the auth obtain the following conclusions. (1) The nuclear deformation is obtained as $\delta_{eq} = 0.35$, which seems to be reasonable in compari with experimental data. (2) About 150% of the value of the spin–o splitting comes from the spin–orbit part of the reaction matrix it lowers the energy of the configuration of the ground state whic has a stable nuclear deformation. (3) The tensor interaction am the particles in the open shell gives only a small contribution to deformation. (4) The self-consistency of Nilsson's model is ver good.

10953 PROTON DISTRIBUTION IN NON-SPHERICAL NUCL Yu.B.Tsekhmistrenko.
Ukrayin. fiz. Zh. (USSR), Vol. 3, No. 1, 139-40 (1958). In Ukrai

10954 GROUND STATES OF Ca ISOTOPES. T.Komoda.
Progr. theor. Phys. (Japan), Vol. 24, No. 1, 201-9 (July, 1960).

The properties of the ground states, the binding energies (pairing energies) and magnetic moment of the isotopes Ca^{42}, Ca and Ca^{24} are studied from the standpoint of configuration mixing All the states with one- and two-particle excitations of $f_{5/2}$ or p_3 particles are mixed with the main configuration $fn_{7/2}J$. The calc lated values of the pairing energies and magnetic moment are in

reement with the experimental values if two-body interaction with Rosenfeld spin mixture is used for the interaction between cleons in the unfilled shell.

10955 NUCLIDES A^{42} AND Cl^{39}. N.Jarmie and M.G.Silbert.
ys. Rev. (USA), Vol. 123, No. 3, 909-10 (Aug. 1, 1961).

The masses of Cl^{39} and A^{42} and the energies of their first cited states were determined by an investigation of the reactions $A^{40}(t,\alpha)Cl^{39}$ and $A^{40}(t,p)A^{42}$. Charged reaction products were analysed with a high-resolution magnetic spectrometer. The experimental results for A^{42} are: mass excess $(M-A) = -34.423 \pm 0.040$ MeV ($C^{12} = 0$) or -21.990 ± 0.040 MeV ($O^{16} = 0$); energy of first excited state $= 1.138 \pm 0.030$ MeV. The experimental results for Cl^{39} are: mass excess $(M-A) = -29.772 \pm 0.040$ MeV ($C^{12} = 0$) -18.227 ± 0.040 MeV ($O^{16} = 0$); energy of first excited state 0.364 ± 0.030 MeV. The Q values of $A^{40}(t,p)A^{42}$ and $A^{40}(t,\alpha)Cl^{39}$ were found to be 7.046 ± 0.040 and 7.259 ± 0.040 MeV, respectively.

10956 POLARIZATION CORRELATION MEASUREMENTS ON Eu^{154}. C.V.K.Baba and S.K.Bhattacherjee.
ys. Rev. (USA), Vol. 123, No. 3, 865-70 (Aug. 1, 1961).

The spins and parities of the 1400 and 1723 keV levels in Gd^{154} are discussed on the basis of the polarization-directional correlation measurements on the 1277–123 and 725–998 keV gamma–gamma cascades following the β decay of Eu^{154}. In the case of the 1277–123 keV cascade, directional correlation measurements and the polarization correlation measurements of the 1277 keV gamma-ray are made with liquid and solid sources. An attenuation in the anisotropy of directional correlation and in the degree of linear polarization correlation was observed in both the sources, the attenuation in the solid source being greater. In the 725–998 keV cascade, the polarization of either of the two radiations was measured in two separate experiments. On the basis of these measurements, the spins and parities of both the 1400 and the 1723 keV levels in Gd^{154} are assigned 2^-. The performance of the apparatus was checked by measuring the polarization correlations of known cascades in Ni^{60}, Ti^{46}, Pd^{106}, and Sr^{88}.

10957 ANTISHIELDING OF NUCLEAR ELECTRIC HEXADECAPOLE MOMENTS. R.M.Sternheimer.
Phys. Rev. (USA), Vol. 123, No. 3, 870-2 (Aug. 1, 1961).

The antishielding factor η_∞ for a possible nuclear electric hexadecapole moment was calculated for the Cu^+, Ag^+ and Hg^{++} ions, using the Hartree–Fock wave-functions for the 3d, 4d, and 5d electrons involved. It was found that $\eta_\infty(Cu^+) \cong -1200$, $\eta_\infty(Ag^+) \cong -8050$, and $\eta_\infty(Hg^{++}) \cong -63\,000$. The implication of these results is discussed.

10958 NUCLEAR ORIENTATION OF Dy^{155} AND Dy^{157}. Q.O.Navarro and D.A.Shirley.
Phys. Rev. (USA), Vol. 123, No. 1, 186-9 (July 1, 1961).

The isotopes Dy^{155} and Dy^{157} were aligned at low temperatures in a single crystal of neodymium ethylsulphate, using the magnetic h.f.s. method. Angular distribution of gamma radiation following the decay of these isotopes was studied as a function of temperature in the region $0.02^\circ K < T < 1^\circ K$. Spin assignments of $\frac{5}{2}-$ were made to states at 227 keV in Tb^{155} and at 327 keV in Tb^{157}. Assuming $I \approx \frac{3}{2}$ for both dypsprosium isotopes as well as pure L = 1 beta decay to the $\frac{5}{2}-$ states, nuclear moments of $|\mu_{155}| = 0.21 \pm 0.05$ n.m. and $|\mu_{157}| = 0.32 \pm 0.02$ n.m. were derived.

10959 NUCLEAR ORIENTATION OF Pm^{143}. C.A.Lovejoy, J.O.Rasmussen and D.A.Shirley.
Phys. Rev. (USA), Vol. 123, No. 3, 954-6 (Aug. 1, 1961).

Pm^{143} was oriented in a crystal of neodymium ethyl sulphate. The angular distribution of the 740 keV γ-ray was found to be $W(\theta) = 1 - (0.065 \pm 0.006) P_2(\cos\theta)$ at $0.02^\circ K$. Values for the mixing ratio, δ, of the 740 keV γ-ray of Nd^{143} were obtained as a function of the magnetic moment of the ground state of Pm^{143}. The spin of the excited state of Nd^{143} was assigned as $\frac{9}{2}-$. An absolute lower limit of $\mu < 1.0$ was set on the magnetic moment of Pm^{143}. The mixing ratio of the γ-ray of Nd^{143} was found to lie in the range $0.23 < \delta(E2/M1) < 0.35$.

10960 NUCLEAR RESONANCE ABSORPTION WITHOUT A RECOIL. (MÖSSBAUER EFFECT).
I.Y.Krause and G.Lüders.
Naturwissenschaften (Germany), Vol. 47, No. 23, 532-6 (1960).
In German.

A review of theoretical and experimental results on the Mössbauer effect. S.J.St-Lorant

10961 HYPERFINE STRUCTURE OF THE 24 keV TRANSITION IN Sn^{119}. O.C.Kistner, A.W.Sunyar and J.B.Swan.
Phys. Rev. (USA), Vol. 123, No. 1, 179-83 (July 1, 1961).

The Zeeman splittings of the two lower levels of Sn^{119} were measured by the method of recoilless emission and resonant absorption of the 24 keV γ-radiation emitted in the decay of Sn^{119m}. The source consisted of Sn^{119m} diffused into 0.002 in. iron foil. Grey tin metal at a temperature of $\sim 10^\circ C$ was used as the absorber. The magnitude of the internal magnetic field at the source nuclei was sufficient to allow resolution of the six absorption peaks resulting from the $\frac{3}{2}+ \rightarrow \frac{1}{2}+$ M1 transition. Measurements were made with the internal fields aligned by application of a small external magnetic field; in this manner the central line of each triplet could be enhanced or suppressed by observing the radiation emitted either perpendicular or parallel to the external field. The splitting parameters obtained from the measurements yield a value of 0.672 ± 0.025 n.m. for the magnetic moment of the first excited state of Sn^{119}, and an effective magnetic field at the tin nuclei in the iron environment of 78.5 ± 2.0 kOe. The chemical shift is such that the transition energy in the source is less than that in the absorber by $(4.24 \pm 0.04) \times 10^{-8}$ eV. Within the limits of measurement, no quadrupole coupling was observed.

EXPERIMENTAL VERIFICATION OF RELATIVITY USING NUCLEAR RESONANCE ABSORPTION. See Abstr. 10411

Energy Levels

10962 THE STATISTICAL MODEL AND NUCLEAR LEVEL DENSITIES. T.Ericson.
Advances in Phys. (GB), Vol. 9, 425-511 (Oct., 1960).

The first part is a review of various models of nuclear level densities, in particular, the equidistant spacing, free gas, Newton–Cameron, Newson, and pairing models. The second part discusses the basis of the statistical model and its application to various types of reaction. A.M.Green

10963 ON THE NON-AXIAL DEFORMATION OF THE MEDIUM AND HEAVY EVEN–EVEN NUCLEI.
J.Hiura and S.Suekane.
Progr. theor. Phys. (Japan), Vol. 24, No. 2, 462-4 (Aug., 1961).

The systematics of the energies of the first and second excited 2^+ states of medium and heavy nuclei are discussed in terms of the aysmmetric rotator model of Davýdov and Filippov (Abstr. 1953 of 1958). L.L.Green

FIRST EXCITED LEVELS OF A^{42} AND C^{39}. See Abstr. 10955

10964 STATES OF Be^{11}, B^{11}, AND C^{11}. P.F.Donovan, J.V.Kane, R.E.Pixley and D.H.Wilkinson.
Phys. Rev. (USA), Vol. 123, No. 2, 589-97 (July 15, 1961).

The gamma-decay of the 4.46 and 5.03 MeV levels of B^{11} was determined by (p,γ) coincidences using the reaction $Be^9(He^3,p)B^{11}$. The 5.03 MeV level is found to decay with a probability of 0.14 ± 0.03 via the state at 2.13 MeV; the intensity of the branch to the state at 4.46 MeV is less than 3×10^{-3}. The intensity of the branch from the 4.46 MeV level vai that at 2.13 MeV is less than 5×10^{-3}. The data on these states are reviewed and it is concluded that the present results strongly favour the choices $J = \frac{1}{2}-, \frac{5}{2}-, \frac{3}{2}-$ for the states at 2.13, 4.46, and 5.03 MeV, respectively, without appeal to a model. It is, however, emphasized that the body of data as it stands at the moment might admit $J = \frac{1}{2}+$ for the 2.13 MeV state and $J = \frac{1}{2}-$ for the 5.03 MeV state. The previsions of the independent-particle model (IPM) are then examined and it is concluded that best general agreement between theory and experiment is achieved for $a/K \cong 4\text{-}4.5$. The likely relevance of the collective model is remarked upon. It is demonstrated with the aid of the reaction $B^{10}(p,\gamma)C^{11}$ that the ordering of the first three excited states of C^{11} is the same as in B^{11}. The beta-decay of Be^{11} is reconsidered in the light of the increased firmness of the assignments in B^{11} and of the previsions of the IPM; it is concluded that Be^{11} is most probably of even parity.

9.6 MeV STATE IN C^{12}: 3^- ASSIGNMENT. See Abstr. 11004

10965 ELECTRON-SCATTERING STUDY OF NUCLEAR LEVELS IN COBALT, NICKEL, LEAD, AND BISMUTH. H.Crannell, R.Helm, H.Kendall, J.Oeser and M.Yearian.
Phys. Rev. (USA), Vol. 123, No. 3, 923-38 (Aug. 1, 1961).

Reports observations of inelastic scattering of 183 MeV electrons through angles of 40°-90° in the laboratory, leading to excitation

of discrete nuclear excited states in Ni^{58}, Co^{59}, Ni^{60}, Pb^{208}, and Bi^{209} The excitation energies were below 8 MeV. Born-approximation analysis of the measured inelastic form factors was used to deduce the multipolarities λ (when not previously known), and, by extrapolation, the transition rates for 15 corresponding gamma-transitions. A number of groups of electric transitions for $\lambda = 2$, 3, and 4 were observed, each group having strikingly similar form factors. In all but one of these groups the ratios G of the observed gamma-transition rates to the single-particle predictions were greater than 15, and for some transitions from 30 to over 100. One of the groups, in cobalt and the nickels, contains the 1.33 MeV E2 transition to the first excited state of Ni^{60}. Another group consists of fast E3 transitions, seen in all five nuclei, from states known as the "anomalous levels." They included the transition to the first excited state in Pb^{208} (G = 31) and a transition in Bi^{209} identical in energy and form factor. Among three slow E4 transitions in cobalt and the nickels was the 2.50 MeV $4^+ \rightarrow 0^+$ transition in Ni^{60}. The E4, E3, and an E2 transition in Co^{59} identify states analogous to the 4^+, 3^-, and 2^+ seen in the neighbouring even-even nuclei. The last two transitions are strongly enhanced. A pair of fast 4.30 MeV E4 transitions was observed in Pb^{208} and Bi^{209}; their speed (G = 37) indicates they may constitute the lowest-energy configuration of 16-pole mode of excitation of the nuclear surface. Values of the collective vibrational parameters C_λ and B_λ and the degree to which some of the transitions exhaust ordinary sum rules support the conclusion that the inelastic scattering process is strongly exciting nuclear collective excitations. Some of the observed results are expected on the basis of the theory of collective vibrational excited states; some are the consequence of unidentified configurations.

10966 T = 3/2 LEVEL IN F^{19} AT 9.07 MeV.

G.Amsel and G.R.Bishop.

Phys. Rev. (USA), Vol. 123, No. 3, 957 (Aug. 1, 1961).

Contrary to previous reports, the authors detected α-particles emitted from the 9.07 MeV state of F^{19} formed by the reaction O^{18} (p,α) N^{15}. The α-particle reduced width indicates that the isotopic spin of this state is $T = \frac{3}{2}$ with an admixture of about 15% of $T = \frac{1}{2}$. The spin of the state is determined to be $\frac{7}{2}$ from the α-particle angular distribution, while odd parity seems to be favoured.

10967 NUCLEAR ENERGY LEVELS OF F^{19}, F^{21}, Ne^{22}, and Ne^{24}.

M.G.Silbert and N.Jarmie.

Phys. Rev. (USA), Vol. 123, No. 1, 221-8 (July 1, 1961).

A 16 in. radius, 180° double-focusing magnetic spectrometer was used to investigate the nuclear energy levels of F^{19}, F^{21}, Ne^{22}, and Ne^{24} by analysis of protons and alpha particles produced by (t,p) and (t,α) reactions with natural neon and with Ne^{22} gas targets. Between excitation energies of 2.8 and 6.5 MeV, new levels in F^{19} were found at 5.102, 5.539, 5.628, 5.937, and 6.169 MeV. Previously reported levels at 3.29, 4.48, and 4.95 MeV were not observed. Up to an excitation energy of 4.3 MeV in F^{21}, new levels were seen at 3.451, 3.509, 3.635, 3977, 4.056, and 4.158 MeV, while the four previously known lower states at 0.285, 1.104, 1.743, and 2.047 MeV were confirmed. The mass of F^{21} was determined to be 21.006624± ±0.000011 a.m.u. (O^{16} standard); (M–A) = 6.168±0.010 MeV. In Ne^{22} 38 excited states were observed up to an excitation of 9.4 MeV. Levels at 1.277, 3.343, and 4.473 MeV were confirmed, while a previously reported level at 4.9 MeV was not observed. Energy levels in Ne^{24}, up to an excitation energy of 6.4 MeV, were found at 1.986, 3.873, 3.962, 4.764, 4.886, 5.576, (5.641), and 6.030 MeV. The mass of Ne^{24} was determined to be 24.001238±0.000011 a.m.u. (O^{16} standard); (M – A) = 1.153±0.010 MeV. Standard deviations in the values for the excitation energies vary from 0.015 to 0.025 MeV. Some representative cross-sections are reported.

In^{116} ACTIVATION RATIOS. See Abstr. 11026

10968 CLUSTER MODEL CALCULATION ON THE ENERGY LEVELS OF THE LITHIUM ISOTOPES.

Y.C.Tang, K.Wildermuth and L.D.Pearlstein.

Phys. Rev. (USA), Vol. 123, No. 2, 548-58 (July 15, 1961).

A variational procedure is adopted to determine the energies of the levels of the highest space symmetry type in Li^6 and Li^7. The trial wave-functions employed take into consideration the existence of cluster structures in those nuclei. With a simple two-body force, it is shown that the computed energies of the various states are in reasonable agreement with experiment. The $^2F_{5/2}$ level in Li^7, as yet undetermined experimentally, is found to have an excitation energy of about 5.6 MeV and a rather large level width. The calculation also indicates that to explain the splitting of levels in those nuclei, a constant two-body spin–orbit force o the pure neutral form is inadequate.

10969 THE ANALYSIS OF THE NUCLEON SPECTRA, A = 4 Ne^{20}, Mg^{24}, Si^{28}, S^{32}. C.G.Bedreag.

An. Stiint. Univ. "Al. I. Cuza" Iasi (Ser. noua) I (Roumania), Vol 7, Pt 1, 129-35 (1960). In French.

An analysis of the nuclear structure of the four elements in terms of the alpha-particle structure is presented together with table of the rotational levels calculated on the basis of this mode The experimental level schemes are compared with theoretical calculations and reasonable agreement obtained. S.J.St-Lorr

10970 ENERGY LEVELS IN ^{13}N.

V.R.McKenna, A.M.Baxter and G.G.Shute.

Austral. J. Phys., Vol. 14, No. 1, 196-9 (March, 1961).

The elastic scattering of protons by carbon in the energy range 5-12 MeV was studied. The angular distribution was meas at 100 keV steps over this energy region. New levels in C^{13} are reported at 8.9, 9.5, 10.4 and 11.6 MeV. L.L.G

10971 9.17 MeV STATE IN N^{14}.

R.E.Segel, J.W.Daughtry and J.W.Olness.

Phys. Rev. (USA), Vol. 123, No. 1, 194-6 (July 1, 1961).

The angular distributions of the 9.17 MeV ground-state gam ray and the gamma rays of the 2.73-6.44 MeV cascade resulting from the 1.75 MeV proton resonance on C^{13} (N^{14*} = 9.17 MeV) we measured. The spins deduced from the angular distributions for the 9.17 MeV state and the 6.44 MeV state agree with previous assignments. The angular momenta admixtures required are fou to be in disagreement with one shell model of N^{14} but it is shown that the model can be brought into accord with experiment by hav the 9.17 MeV state wave-function include a configuration with a nucleon in the f shell.

10972 ENERGY LEVELS IN Na^{21}.

R.E.Benenson and L.J.Lidofsky.

Phys. Rev. (USA), Vol. 123, No. 3, 939-47 (Aug. 1, 1961).

The Na^{21} nucleus was studied through two reactions: the Ne^{20} (d,n) Na^{21} reaction using a fast-neutron spectrometer, and th Ne^{20} (p,γ) Na^{21} reaction using both single-crystal and Hoogenboom techniques. E_d for the neutron spectroscopy for the major part of the work was centred about 4.87 MeV, while the capturing resonance for the gamma-ray work was at E_p = 1.17 MeV. Enric neon was employed as target gas. Energy levels in Na^{21} are found at excitations of 0.33 ± 0.03 MeV, 1.77 ± 0.05 MeV, 2.42 ± 0.04 Me 2.80 ± 0.06 MeV, and 3.61 ± 0.06 MeV. From the neutron work level parameters can be assigned to the 0.33 and 2.42 MeV levels while the from gamma-ray work spin limits and parity may be assigned to the 3.61 MeV level. This latter level corresponds to the 1.17 MeV capture resonance, and a study of the de-excitation cascades has been partially completed. A discussion of the level scheme of Na^{21} in terms of the collective model is given.

ENERGY LEVELS IN $_{69}Tm^{172}$ FROM THE DECAY OF $_{68}Er^{172}$. See Abstr. 10977

10973 NEW YTTRIUM ISOMERS OF MASSES 86 AND 90.

L.Haskin and R.Vandenbosch.

Phys. Rev. (USA), Vol. 123, No. 1, 184-5 (July 1, 1961).

Cyclotron bombardment of Rb with α-particles and Sr with deuterons yielded two new yttrium activities. Y^{86m} decays with a half-life of 49.0 ± 1.5 min. The isomer is supported by a highly converted 7.2 keV isomeric transition followed by a 210 keV gam ray having a conversion coefficient $e/\gamma = 0.06 \pm 0.01$. Y^{90m} has half-life of 3.19 ± 0.06 hr, decaying to the Y^{90} ground state with emission of two gamma-rays: 476 keV, $e/\gamma = 0.10 \pm 0.02$, and 203 keV, $e/\gamma = 0.036 \pm 0.007$. Spin and parity assignments are m for the Y^{90} levels.

10974 3.14 HR ISOMERIC LEVEL IN Y^{90}.

R.L.Heath, J.E.Cline, C.W.Reich, E.C.Yates and E.H.Turk.

Phys. Rev. (USA), Vol. 123, No. 3, 903-9 (Aug. 1, 1961).

A previously unreported 3.14 hr isomeric activity was produced in Y^{90} by thermal-neutron irradiation of Y^{89}. The thermal-capture cross-section for the production of the isomer was meas ured to be 1.0 ± 0.2 mb. The decay of the isomeric level is char terized by the emission of two cascade gamma-rays of 0.482 and 0.203 MeV. Conversion-coefficient measurements indicated that

e isomeric level at 0.685 MeV decays by M4 or E5 radiation to an termediate level at 0.203 MeV followed by a predominantly M1 ansition to the ground state of Y^{90}. Gamma—gamma directional- rrelation measurements and internal-conversion measurements dicated that the level at 0.203 MeV has spin 3 with odd parity and at the level at 0.685 MeV has spin 7 or 8 with even parity. A ell-model configuration of $(g_{9/2}d_{5/2})$ was assigned to the isomeric ate.

NUCLEAR DECAY RADIOACTIVITY

ANGULAR ASYMMETRY THEOREMS FOR DECAY PRODUCTS.
ee Abstr. 10868

TABLE OF RADIOACTIVE NUCLIDES. See Abstr. 11047

10975 THE DECAY OF THE TWO-HOUR ISOTOPE Lu^{168}.
E.P.Grigor'ev, K.Ya.Gromov, B.S.Dzhelepov, V.Zvol'ska .V.Zolotavin, M.Veis and Van Yun-yui [Wang Yung-yü].
Dokl. Akad. Nauk SSSR, Vol. 136, No. 2, 325-8 (Jan. 11, 1961).
n Russian.

The conversion lines with a 2-hour half-life observed after the rradiation of Ta by 660 MeV protons are shown to arise from the lecay of an isomeric state of Lu^{168} to an excited level of Yb^{168}. The 87.6 keV transition from the excited level to the ground state of Yb^{168} is found to be of the E2 type. [English translation in: Soviet Physics — Doklady (USA), Vol. 6, No. 1, 46-8 (July, 1961)]. J.E.Gore

10976 DECAY OF Tm^{172}.
R.G.Helmer and S.B.Burson.
Phys. Rev. (USA), Vol. 123, No. 3, 978-91 (Aug. 1, 1961).

The radioactive nuclide $_{69}Tm^{172}$ was produced by successive capture of two neutrons in erbium oxide enriched in Er^{170}. In addition to three thulium activities, these samples contained six active contaminants. Pure thulium sources were obtained by use of an ion-exchange column. Studies were conducted with a 256-channel coincidence scintillation spectrometer. These measurements indicate the presence of a least 17 gamma-ray and 5 beta-ray transitions. The beta-ray spectrum was studied with a 180° magnetic beta-ray spectrometer. This spectrum was analysed by use of a computer program compiled by the authors in collaboration with members of the Argonne Applied Mathematics Division. The level scheme proposed for Yb^{172} has states with energies, spins, and parities of 0.0(0^+), 0.079(2^+), 0.260(4^+), 1.17(3), 1.46(2), 1.54(3), 1.60(1), 1.64(?), and 1.73(3) MeV. The total decay energy is found to be 1.88 MeV. The experimental data are consistent with the previously proposed interpretation that the first two excited states are members of a K=0 rotational band based on the ground state. The states at 1.46 and 1.54 MeV are interpreted as members of a rotational band with K=2. The states at 1.60 and 1.73 MeV are tentatively interpreted as members of a rotational band with K=0 and negative parity. It is suggested that the state at 1.17 MeV has K=3. From the analysis of the beta spectrum it is concluded that the ground state of thulium has I=K=2 and negative parity.

10977 ENERGY LEVELS IN $_{69}Tm^{172}$ FROM THE DECAY OF $_{68}Er^{172}$. R.G.Helmer and S.B.Burson.
Phys. Rev. (USA), Vol. 123, No. 3, 992-6 (Aug. 1, 1961).

The radioactive nuclide $_{68}Er^{172}$ was produced by the successive capture of two neutrons in erbium oxide enriched in Er^{170}. In addition to three erbium activities and the radioactive Tm^{172} daughter, these samples contained six active contaminants from which the erbium was separated by use of an ion exchange column. Scintillation studies, conducted with a 256-channel coincidence scintillation spectrometer, indicate the presence of at least eight gamma-ray transitions. Two of these transitions are either highly K converted or their transition energies are approximately 50 keV. The energies of the other six transitions are about 610, 450, 408, 200, 160, and 125 keV. Beta–gamma coincidence experiments indicate the presence of two beta-ray components at approximately 310 keV (in coincidence with the 610 keV gamma-ray) and 370 keV (in coincidence with the 408 keV gamma-ray). The level scheme deduced for Tm^{172} has excited states at 408, 450 (or 160), 470±15, 530, and 610 keV. From the beta-ray intensities, the states at 530 and 610 keV are assigned spins of either 0 or 1 with positive parity. The spin and parity (2^-) of the thulium ground state have previously been assigned from the properties of the decay of Tm^{172}.

10978 LIFE TIME OF Sn^{116} LEVELS.
R.Stiening and M.Deutsch.
J. Phys. Radium (France), Vol. 21, No. 4, 261 (April, 1960).
In French.

The cascade of retarded coincidences between γ-rays of Sn^{116} resulting from In^{116m} disintegration was studied, determining the spectrum of the 2.1 MeV-0.4 MeV cascade. The apparatus employed consisted of a NaI(Tl) crystal (3 in. diam., 3 in. thick) coupled with an RCA 7046 photomultiplier for the 2 MeV ray, and a 1 in. crystal coupled with an RCA 7265 photomultiplier. The spectrum obtained was compared with a standard spectrum obtained with a source of quasi-simultaneous coincidences. It is shown that the intensity of an eventual cascade of 10^{-5} lifetime is less than 2% the total intensity. Less than 75% of the coincidences have a period of less than 0.5 mμs.
L.Mordecai

10979 HALF-LIFE OF SAMARIUM-147.
P.M.Wright, E.P.Steinberg and L.E.Glendenin.
Phys. Rev. (USA), Vol. 123, No. 1, 205-8 (July 1, 1961).

A liquid scintillation counting technique was applied to the determination of the half-life of Sm^{147} by specific α-activity measurement. A value of $(1.05 \pm 0.02) \times 10^{11}$ years is obtained.

RATIOS OF THE RENORMALIZED AND THE BARE COUPLING CONSTANTS IN THE BETA DECAY INTERACTION.
See Abstr. 10844

10980 COULOMB FIELD EFFECTS IN BREMMSTRAHLUNG PROCESSES ASSOCIATED WITH β-DECAY.
R.Vinh-Mau.
Nuovo Cimento (Italy), Vol. 19, No. 3, 609-11 (Feb. 1, 1961).

The effects of the nuclear Coulomb field on internal bremsstrahlung accompanying β-decay are considered. Relativistic Coulomb wave-functions are used both for the intermediate and final electron states. The radial integrals are evaluated in terms of generalized hypergeometric functions. Numerical results for S^{35} are given. The corrections to the first Born approximation are not negligible. T.Erber

10981 TWICE FORBIDDEN BETA-RAY TRANSITION OF Co^{60}.
D.C.Camp, L.M.Langer and D.R.Smith.
Phys. Rev. (USA), Vol. 123, No. 1, 241 (July 1, 1961).

The high-energy beta-ray transition from the ground state of Co^{60} to the first excited of Ni^{60} was studied in a magnetic spectrometer. The shape of the beta-ray spectrum is found to be consistent with that expected for a "unique" twice-forbidden transition from a 5+ to a 2+ level. The relative intensity of this 1.48 MeV transition is found to be 0.12%. The comparative half-life is $\log(\langle S_e^3 \rangle f_0 t) = 11.8$, which is in close agreement with the values found for the other "unique" twice-forbidden transitions of Be^{10} and Na^{22}.

10982 NEW BRANCHING RATIO FOR Kr^{85}.
K.W.Geiger, J.S.Merritt and J.G.V.Taylor.
Nucleonics (USA), Vol. 19, No. 1, 97-101 (Jan., 1961).

Absolute measurements made of the β rays and the 0.517-MeV gamma-ray yield a branching ratio of 0.46 ± 0.04% R.D.Smith

10983 BETA-DECAY COUPLING CONSTANT AND THE ft VALUE OF O^{14}. R.J.Blin-Stoyle and J.Le Tourneux.
Phys. Rev. (USA), Vol. 123, No. 2, 627-8 (July 15, 1961).

A calculation is made of the effect of a charge-dependent internucleon potential on the $O^{14}(0^+, T = 1) \rightarrow N^{14}(0^+, T = 1)$ β-decay matrix element. It is found that a not unreasonable strength and form for such a potential can lead to a reduction in the matrix element $\cong 1\%$ which is of the right order of magnitude to resolve the present discrepancy between the β- and μ-decay polar vector coupling constants.

10984 POSITRON SPECTRA OF Co^{56}.
J.H.Hamilton, L.M.Langer and D.R.Smith.
Phys. Rev. (USA), Vol. 123, No. 1, 189-93 (July 1, 1961).

The positron spectrum of Co^{56} was carefully studied with a magnetic spectrometer. Two positron groups were observed. The maximum energies and intensities of the two groups are 1.464 ± 0.015 and 0.440 ± 0.030 MeV and ≥ 90% and ≤ 10%, respectively. No evidence for any other groups was found. In particular, an upper limit of 1% was set for the presence of any group with maximum energy

0.9-1.0 MeV. The high-energy spectrum has essentially an allowed shape. However, the inclusion of a shape factor such as $(1 + 0.3/W)$ offers a more consistent fit to all the data.

10985 THE ABSOLUTE CALIBRATION OF DECAY RATES BY MEANS OF THE $\beta-\gamma$ COINCIDENCE METHOD AND ITS USE IN THE MEASUREMENT OF THE THERMAL ACTIVATION CROSS-SECTION OF THE ISOTOPES Na^{23}, Sc^{45}, Co^{59} AND Ta^{181}. G.Wolf.
Nukleonik (Germany), Vol. 2, No. 7, 255-71 (Dec., 1960).
In German.

A new method of determining the activation cross-section of a number of isotopes commonly in use for flux measurements of thermal neutrons is presented. The $\beta-\gamma$ and $4\pi\beta-\gamma$ coincidence techniques are discussed and the statistical errors of the latter evaluated. Precautions and technical improvements are described. The half-life of Na^{24} is obtained as 14.953 ± 0.013 hours. The activation cross-sections measured are: Na^{23}: 0.51 ± 0.008; Co^{59}: 38.0 ± 0.5; Sc^{45}: 28.3 ± 0.7; Ta^{181}: 21.0 ± 0.7; in units of 1 barn. Agreement with previous work is good except for the case of Sc^{45}. S.J.St-Lorant

10986 NUCLEAR ELECTRIC MONOPOLE TRANSITION IN Ca^{42}. N.Benczer-Koller, M.Nessin and T.H.Kruse.
Phys. Rev. (USA), Vol. 123, No. 1, 262-5 (July 1, 1961).

The 0^+ assignment to the 1.836 MeV, second-excited state in Ca^{42}, was confirmed by the observation of electric monopole electron–positron pairs and internal conversion electrons corresponding to the cross-over transition to the ground state. The shape of the continuous positron spectrum from the E0 pairs, as well as the ratio R = 9.0 ± 1.8 of pairs to E0 conversion electrons, are consistent with theoretical predictions for an E0 transition. 0.305 MeV internal conversion electrons were observed corresponding to the transition between the 1.836 MeV and the 2^+, 1.523 MeV, first excited state. The ratio of 1.836 MeV to 0.305 MeV electron yields is 1.03 ± 0.10. From these and other data the monopole strength parameter ρ was determined to be 0.41.

10987 BETA–GAMMA DIRECTIONAL CORRELATION IN Eu^{154}. K.S.R.Sastry, R.F.Petry and R.G.Wilkinson.
Phys. Rev. (USA), Vol. 123, No. 2, 615-18 (July 15, 1961).

The energy dependence of the beta–gamma angular correlation between the outer beta-ray group of Eu^{154}, W_0 = 1.86 MeV, and the 123 keV gamma-ray of the daughter Gd^{154} was measured with a shaped magnetic field beta–gamma coincidence spectrometer. A negative correlation coefficient, accurate to about 5%, is obtained which ranges from −0.10 to −0.17 in the energy region 0.80 to 1.60 MeV. It is shown that the modified B_{ij} approximation must be relaxed to explain the data. The nuclear parameters (Kotani's notation) which result are: x = − 0.24 ± 0.05, u = + 0.05 ± 0.03, Y = + 0.76 ± 0.08. These values are compared with those which have been reported for Eu^{152}: x = u = 0, Y = 0.69 ± 0.06.

10988 M1-TRANSITION IN V^{51} AND CONFIGURATION MIXING. T.Komoda.
Progr. theor. Phys. (Japan), Vol. 24, No. 5, 1078-82 (Nov., 1960).

The M1-transition probability of the 0.321 MeV level of V^{51} is calculated on the basis of configuration mixing. The calculated values are satisfactory in comparison with experimental value of Delyagin and Preisa (Abstr. 11389 of 1960). In the calculations, the Rosenfeld mixture type of spin exchange forces is used for the two-body interaction between particles in the unfilled shell. For justification of this standpoint, the magnetic moment of V^{51} is calculated. The result is almost in agreement with the experimental value.

10989 ORBITAL ELECTRON CAPTURE RATIO AND BETA SPECTRUM OF ^{204}Tl. B.R.Joshi.
Proc. Phys. Soc. (GB), Vol. 77, Pt 6, 1205-9 (June, 1961).

A direct measurement of the L/K electron capture ratio was made for Tl^{204}. An improved internal source scintillation counter technique was used. A crystal was grown containing Tl^{204} and this crystal was totally enclosed in a well-type crystal. The experimental value obtained for this unique first forbidden transition (ΔJ = 2, yes) is 0.42 ± 0.05. This value may be compared with the value 0.52 ± 0.05 calculated from the electron capture transition energy. In addition, information was obtained on the β^--decay branch. The low-energy end of the Fermi–Kurie plot of the β^--spectrum, after applying an exact shape correction factor, deviates slightly downwards from a straight line. This deviation is in the opposite sense from that obtained by previous workers with magnetic spectrometers.

10990 THE K INTERNAL CONVERSION COEFFICIENT O THE 412 keV TRANSITION IN Hg^{198}. J.L.Wolfson.
Canad. J.Phys., Vol. 39, No. 5, 773-7 (May, 1961).

It has recently been concluded (Frey, Hamilton and Hultberg Bull. Amer. Phys., Vol. 5, 448, 449, that the latest E2 conversic coefficients of high-Z unhindered transitions may be in substant error. This paper draws attention to previously reported measu ments made some years ago at Chalk River which do not suppor the conclusion of Hamilton et al. that α_K for the 412 keV transit in Hg^{198} is anomalously low. L.L.Gr

10991 THE CONVERSION ELECTRON SPECTRUM FROM A MASS-SEPARATED SOURCE OF Xe^{133}. F.Brown, R.L.Graham, G.T.Ewan and J.Uhler.
Canad. J. Phys., Vol. 39, No. 5, 779-80 (May, 1961).

The conversion electrons from a source of Xe^{133}, separated by a Nobel Institute type mass separator, were studied, using the Chalk River iron-free β-ray spectrometer. The ratios of the K, L_1,L_2,L_3, lines from the 80.99 ± 0.02 keV γ-transition in Cs^{133} following β-decay from Xe^{133} are used to obtain the multipolarity of this transition. L.L.Gr

10992 DIRECTIONAL CORRELATION MEASUREMENTS IN Hf^{178}. U.Bertelsen, J.Borggreen and O.Nathan.
Phys. Rev. (USA), Vol. 123, No. 2, 564-7 (July 15, 1961).

Measurements of the directional correlation of the 1335–93 1345-93 keV, and 1390-93 keV $\gamma-\gamma$ cascades in Hf^{178} were made, u a liquid source of 21 day W^{178} in equilibrium with 9.3 min Ta^{178}. is shown that the data support the tentative spin assignments of Gallagher, et al. (Abstr. 8621 of 1961). The 1390 keV γ-ray is fo to be almost pure quadrupole radiation. If the spin and parity of 1430 keV level is 1+, as suggested by Gallagher et al., the multip rity of the 1335 keV γ-ray is determined by the reported measur ments to be mainly M1. Using these results, the amount of E0 ra tion in the 1309 keV transition has been estimated. It is found th approximately 70% of the 1390 keV K-conversion electrons are d to monopole transitions.

10993 DETERMINATION OF M1–E2 MIXING AMPLITUDES I Mg^{25}, Al^{27}, Si^{29}, AND P^{31}. G.J.McCallum.
Phys. Rev. (USA), Vol. 123, No. 2, 568-78 (July 15, 1961).

A method of analysing gamma-ray angular distribution and direction-polarization data to yield values for the relative ampli tudes of mixed multipole gamma-ray transitions is described. T analysis of the data does not demand a knowledge of the mechani of formation of the gamma-emitting level. Measurements are re ported on some mixed M1–E2 de-excitation gamma rays from lo lying levels in Mg^{25}, Al^{27}, Si^{29}, and P^{31}; these levels were excite inelastic proton scattering. The following results were obtained:

Nucleus	Initial state Energy (MeV)	Spin and parity	Final state Energy (MeV)	Spin and parity	E2 amplit / M2 amplit
Mg^{25}	0.98	$\frac{3}{2}$+	ground state	$\frac{5}{2}$+	0.30 ± 0
	0.98	$\frac{3}{2}$+	0.58	$\frac{1}{2}$+	0.15 ± 0
Al^{27}	1.01	$\frac{3}{2}$+	ground state	$\frac{5}{2}$+	−0.32 ± 0
Si^{29}	1.28	$\frac{3}{2}$+	ground state	$\frac{1}{2}$+	0.21 ± 0
P^{31}	1.27	$\frac{3}{2}$+	ground state	$\frac{1}{2}$+	−0.25 ± 0

10994 LIFETIMES OF ENERGY LEVELS IN Al^{28}, Mn^{56}, Cu Rh^{104}, AND I^{128} EXCITED BY SLOW NEUTRON CAPTURE. S.J.Du Toit and L.M.Bollinger.
Phys. Rev. (USA), Vol. 123, No. 2, 629-36 (July 15, 1961).

Measurements of delayed coincidences between γ-rays were used to determine the half-lives of states excited by slow-neutro capture in various nuclei. The half-lives found were: Mn^{56}, firs excited level 11.4_{-3}^{+2} nsec, second excited level 5.1 ± 0.5 nsec; Rh^{104}, first excited level 2.6 ± 0.2 nsec, 96 keV transition ≤0.6 n Cu^{64}, first excited level ≤0.3 nsec, second excited level ≤0.3 nse Al^{28}, first excited level 2.3 ± 0.2 nsec; I^{128}, 30 keV level 8.8 ± 1.0 nsec, 137 keV level 8.0 ± 0.6 nsec, 90 keV transition ≤0.7 nsec. Measurements of pulse-height spectra satisfying th condition of prompt and delayed coincidence and measurements neutron resonances of iodine were used to establish the presenc of excited states at 30 and 137 keV in I^{128}. A previously unrepor neutron resonance was observed in I^{127} at a neutron energy of 10.7 eV.

10995 SHORT-LIVED ISOMERS OF Ge^{71}, As^{74}, Br^{78}, AND Tc. A.W.Schardt and A.Goodman.
ys. Rev. (USA), Vol. 123, No. 3, 893-7 (Aug. 1, 1961).

Short-lived isomers were produced with the pulsed beam of a n de Graaff generator and observed between pulses with scintilla- n detectors. The results are summarized in the following table:

sotope	Half-life	Isomeric transition (keV)	Observed gamma ray (keV)
Ge^{71}	20.3 ± 0.3 msec	23 (M2)	175
As^{74}	8.0 ± 0.3 sec	283 (M3)	283 ± 5
Br^{78}	118.0 ± 1.5 μsec	149 (M2)	149 ± 2, 32 ± 2
Tc	8.15 ± 0.20 μsec		177 ± 4
Tc	15.5 ± 0.8 μsec		43 ± 3

NUCLEAR REACTIONS

(Including scattering by nuclei)

10996 EFFECT OF COMPETITION BETWEEN GAMMA-RAY AND PARTICLE EMISSION ON EXCITATION FUNC- IONS. J.R.Grover.
hys. Rev. (USA), Vol. 123, No. 1, 267-75 (July 1, 1961).

A procedure is devised for calculating cross-sections for uclear reactions within about 2 MeV of threshold, where the effect competition between gamma-ray and particle emission is often nportant. The requisite formulae depend upon assumptions nbodied in the spin-dependent statistical theory of nuclear re- ctions, so the treatment is most valid for medium to heavy nuclei t moderate bombarding energies. Input data required by the ormulae are (1) the level density parameter a, (2) an effective uclear moment of inertia $\mathcal{I}$, (3) the ratio of radiation width to level pacing (Γ_γ/D) evaluated at some convenient energy, spin, and parity n the excited nucleus immediately preceding the product, (4) trans- ission coefficients $T_l(\epsilon)$ for the range of energies and type of article in the final evaporation step, and (5) the energies, spins, nd parities of the first few excited states in the product nucleus. Using reasonable estimates for $\mathcal{I}$, Γ_γ/D, and $T_l(\epsilon)$, experimental xcitation functions near threshold for the reactions $Bi^{209}(p,2n)Po^{208}$ nd $Sm^{144}(\alpha,3n)Gd^{145}$ were analysed to find the corresponding values f a. The results are consistent with a~0.1 A MeV^{-1} (A is the mass umber), but inconsistent with a~2 to 3 MeV^{-1} (independent of A), in ontrast to the result often obtained when competition from gamma- ay emission is ignored. Also, a semiqualitative argument is given o suggest that competitive gamma-ray emission often seriously nfluence excitation functions even several MeV above threshold.

10997 DIFFRACTION NUCLEAR PROCESSES AT HIGH ENERGIES. O.I.Akhiyezer and O.H.Sȳtenko.
Ukrayin. fiz. Zh. (USSR), Vol. 3, No. 1, 16-34 (1958). In Ukrainian.

10998 THE THEORY OF NUCLEAR REACTIONS INVOLVING COMPLEX PARTICLES. O.H.Sȳtenko.
Ukrayin. fiz. Zh. (USSR), Vol. 4, No. 2, 152-62 (1959). In Ukrainian.

Considered in the quasiclassical approximation. The kinetic energy of an incident complex system scattered by a central field is assumed to be large in comparison with the coupling energy. The interaction of the complex system with the central field is described by means of a unit scattering matrix, represented in the form of the product of the scattering matrices for the individual particles included in the complex system $S = \Pi S_k$. The asymptotics of the wave-functions of the relative motion of the complex system and the scattering centre after collision are found by means of Huygens' principle. The amplitude of scattering for a system of particles in a central field is given. The total cross-sections of elastic and inelastic scattering are defined. The total cross-section of complete scattering $\sigma_S = \sum_j \sigma_{1j}$ is also given. Processes are described where the number of particles in the incident system remains unchanged: elastic scattering, scattering with excitation of the incident system, and scattering attended by a partial or complete disintegration of this system. The distribution of the recoil particles by momenta is defined. A general expression is also obtained for the complete reaction cross-section under the influence of the incident complex system. The reaction cross-section σ_r describes all processes during which the number of particles in the initial system changes: the absorption of the whole system by the scattering centre, partial absorption, the stripping reaction of individual particles, etc. The total cross-section of all processes is given. In the case of weak interaction $|\eta_k| \ll 1$ the results obtained agree with the results of the Born approximation. The cross-section of stripping reaction is found when one of the particles originally entering into the incident system is captured by the scattering centre. The distribution of the liberated particles in stripping by momenta is defined. The results obtained are applicable not only to the scattering of a system of interacting particles on a scattering centre, but may also be applied to the scattering of an individual particle on a system of interacting particles.

Due to Photons

10999 PHOTODISINTEGRATION OF Be^9 FROM THRESHOLD TO 5 MeV. M.J.Jakobson.
Phys. Rev. (USA), Vol. 123, No. 1, 229-30 (July 1, 1961).

A bremsstrahlung-photon difference method measurement of the $Be^9(\gamma,n)$ cross-section indicates maxima in the cross-section of 1.15±0.15, 0.55±0.1, 1.2±0.2, and 1.0±0.3 mb at energies of 1.70, 2.40, 2.95, and 4.6 MeV, respectively. The angular distribution of the neutrons corresponding to the 1.70 and 4.6 MeV peaks is spherically symmetric; $d\sigma/d\Omega = \alpha + b\sin^2\theta$ ($\alpha/b = 1.0 \pm 0.2$) for the 2.95 MeV peak.

PHOTODISINTEGRATION OF Ne^{22}.
11000 A.P.Komar, Ya.Krzhemenek and I.P.Yavor.
Dokl. Akad. Nauk SSSR, Vol. 135, No. 2, 291-3 (Nov. 11, 1960). In Russian.

For abstract, see Abstr. 3436 of 1961. [English translation in: Soviet Physics–Doklady (USA), Vol. 5, No. 6, 1234-6 (May-June, 1961)].

11001 "BREAKS" IN THE ACTIVATION CURVE OF THE $P^{31}(\gamma,n)P^{30}$ REACTION. D.Sadeh.
Phys. Rev. (USA), Vol. 123, No. 3, 855-8 (Aug. 1, 1961).

Discontinuities in the slope of the activation curve of the $P^{31}(\gamma,n)P^{30}$ reaction were found while using two large NaI(Tl) crystals to detect the annihilation gammas from P^{30}. These breaks correspond well with resonances found recently in the $Si^{30}(p,n)P^{30}$ reaction. The correspondence between breaks and known resonances in some light nuclei is discussed. Such a correspondence was found to exist in the case of N^{14}, F^{19}, and P^{31} and is in doubt in the case of C^{12}. The detection system used allowed accurate measurements of the thresholds of the $P^{31}(\gamma,n)P^{30}$ reaction (12.23±0.04 MeV) and the $Cl^{35}(\gamma,n)Cl^{34}$ reaction (12.66±0.04 MeV).

11002 PHOTO–ALPHA REACTION IN Sb^{121}.
J.H.Wolfe and J.P.Hummel.
Phys. Rev. (USA), Vol. 123, No. 3, 898-902 (Aug. 1, 1961).

The $Sb^{121}(\gamma,\alpha)In^{117-117m}$ reaction was studied by determining the radioactivities of the product nuclei in samples that were irradiated with bremsstrahlung of maximum energy varying from 15.5 to 24 MeV. Excitation functions for the total cross-section and the cross-sections to each isomer were obtained. The total cross-section rises steadily over the energy range studied, reaching a value of 360 μb at 24 MeV. The ratio of the cross-section for the direct production of the ground state to the cross-section for the production of the isomer is constant over the energy range studied at a value of 2.60 ± 0.40. The total excitation function up to 18 MeV agrees well with cross-sections calculated on the basis of a statistical theory for compound-nucleus decay. The cross-section predictions could not be made for higher energies. The observed ground-state-to-isomer cross-section ratio is consistent with that expected from a compound-nucleus mechanism and probably inconsistent with that expected from a direct mechanism. Thus, the reaction appears to involve compound-nucleus processes for the most part.

11003 ISOMER RATIO FOR THE $Sn^{115}(\gamma,p)$ REACTION.
J.P.Hummel.
Phys. Rev. (USA), Vol. 123, No. 3, 950-3 (Aug. 1, 1961).

The relative yields of In^{115} from the $Sn^{115}(\gamma,p)$ reaction were measured by gamma-ray counting a sample of SnO_2 enriched in Sn^{115} that had been irradiated with 24 MeV bremsstrahlung. The measured ground to isomer yield ratio was 0.65 ± 0.15, and is consistent with predictions made on the basis of both the Wilkinson direct mechanism (Abstr. 1973 of 1958) and the compound-nucleus mechanism. However, the values of the isomer ratios for the series

of even-even tin isotopes [Sn^{118}, Sn^{120}, Sn^{122}, and Sn^{124}, the later three from the work of Yuta and Morinaga (Abstr. 11352 of 1960)] are not at all consistent with the predictions of the compound-nucleus mechanism but can be rationalized on the basis of the Wilkinson model, lending support for that theory for direct photoproton reactions.

Due to Nucleons

11004 INELASTIC SCATTERING OF 18.9 MeV NUCLEONS FROM THE 9.6 MeV STATE OF C^{12}.

E.Bradford and B.A.Robson.

Phys. Rev. Letters (USA), Vol. 6, No. 10, 550-1 (May 15); erratum, ibid., Vol. 6, No. 12, 711 (June 15, 1961).

The data on inelastic scattering of 18.9 MeV protons by C^{12} are reanalysed, taking into account spin–orbit effects and volume effects in addition to direct surface interaction. It is suggested that the data for the 9.6 MeV state in C^{12} are in better agreement with a 3^- assignment for this state than 1^-. L.L.Green

HIGH-ENERGY NUCLEON ELASTIC SCATTERING FROM LIGHT NUCLEI. See Abstr. 10885

Due to Protons

11005 ON THE INELASTICALLY SCATTERED PROTON AND THE DIPOLE γ-ABSORPTION. Y.Sakamoto.

Progr. theor. Phys. (Japan), Vol. 24, No. 1, 81-96 (July, 1960).

The energy spectra and the angular distribution of the protons inelastically scattered from the levels in the giant dipole γ-resonance region are investigated by taking into account the nuclear interaction, as well as the Coulomb interaction, between the incident proton and the nucleons in the target nucleus. The calculated results for some nuclei are compared with experiment. It is pointed out that, as with the results of nuclear interactions, the spin flip parts of the target nucleons in the nucleus play an important role. Based on the fair agreement of the calculated results with observed ones, it is proposed that the measurements of (p,p') scattering provide a powerful tool to investigate the giant dipole γ-resonance, and that the measurements give an effective way of studying the nuclear matrix elements.

11006 ENERGY DEPENDENCE OF ANGULAR DISTRIBUTIONS OF THE REACTION $Al^{27}(p, \alpha)Mg^{24}$ IN THE ENERGY REGION BETWEEN 10.5 AND 14.5 MeV.

H.Ogata, H.Itoh, Y.Masuda, K.Takamatsu, M.Kawashima, A.Masaike and I.Kumabe.

J. Phys. Soc. Japan, Vol. 15, No. 10, 1719-25 (Oct., 1960).

The angular distributions of the reactions resulting in the ground and first excited states of Mg^{24} were measured at 37 energies between 10.5 and 14.5 MeV, making use of proportional counters. Similar behaviour was obtained for both reactions. The variation of the shape of the angular distributions with the bombarding energy. There appear some resonance-like peaks and valleys in the excitation curves at laboratory angles of 50°, 90° and 130° but their positions are not coincident with one another and in the higher energy region these peaks disappear in the excitation curves for the total cross-sections. The variations of the excitation curves for the total cross-sections and of the shape of the angular distributions with energy in the lower energy region may be due to the fluctuations in the number or properties of the compound nucleus levels and to the interference between the compound nucleus and direct interaction processes. The smoothings-out of the excitation curves for the total cross-sections and of the variation of the shape of the angular distributions in the higher energy region seem to be due to the effects of decreasing level spacing in the compound nucleus and of increasing contribution from the direct interaction process. However, in the entire energy region, the interference between the compound nucleus and direct interaction processes and some contribution from the heavy particle stripping process cannot be neglected.

11007 EVIDENCE FOR SEQUENTIAL TWO-BODY DECAY IN THREE-BODY DECAY OF C^{12} AND B^{10}.

E.H.Beckner, C.M.Jones and G.C.Phillips.

Phys. Rev. (USA), Vol. 123, No. 1, 255-61 (July 1, 1961).

The reactions $B^{11}(p, \alpha)Be^8$ and $Be^9(p, d)Be^8$ were studied by employing monoenergetic protons, thin targets, and a low-background magnetic spectrometer to resolve the disintegration products. The continuum spectra of alpha and deuteron particles produced, respectively, the the reactions were compared to the generalized density-of-states function of Phillips, Griffy, and Biedenharn [Abstr. 3402 of 1961; Bull. Amer. Phys. Soc., Vol. 5, 44 (1960)] and good fits were obtained. The density function was calculated from the experimental (α, α) scattering phase shifts. The calculated S-wave density function for Be^8 predicts a low-energy anomaly. This anomaly was observed and confirms the assumption of the model used to calculate this spectral shape: three-body decay proceeding via a sequence of two-body decay modes.

11008 LOSS OF C^{11} FROM PLASTIC FOILS AND ITS EFFECT ON CROSS-SECTION MEASUREMENTS.

J.B.Cumming, A.M.Poskanzer and J.Hudis.

Phys. Rev. Letters (USA), Vol. 6, No. 9, 484-5 (May 1, 1961).

In the course of measurements of the ratio of the cross-sections for the $C^{12}(p,pn)C^{11}$ and $Al^{27}(p,3pn)Na^{24}$ reactions using stacked polyethylene and aluminium foils it was found that up to 15% of the C^{11} activity may be lost by the plastic foils during irradiation. The effect is ascribed to hot-atom reaction leading to gaseous products which diffuse out of the target. S.J.St-Lor

11009 MEASUREMENT OF THE EFFECTIVE CROSS-SECTION OF THE $C^{12}(p,\gamma)$ REACTION. O.S.Deineko

Ukrayin. fiz. Zh. (USSR), Vol. 4, No. 1, 52-6 (1959). In Ukrainia

Measured in the energy range 200-400 keV of the bombardin particles. The method of quantitative determination of the β-active product of the reaction was used. The target consisted a pure carbon of natural isotopic composition. The positron activity was measured by an end window counter with a mica window 15 μ thick. The counting efficiency of the counter was determined by a comparison of the relative yield curve obtained with the aid of the counter and a valve electrometer. The results were compared with those of other authors (Abstr. 4340 of 1950). The comparison shows a satisfactory agreement of the given cross-sections. Satisfactory agreement was also obtained on comparing the present results with the theoretical calculations b the Breit-Wigner formula with the assumption of constant resonance at 456 keV.

11010 ANGULAR DISTRIBUTION OF THE GROUND-STATE NEUTRONS FROM THE $C^{13}(p, n)N^{13}$ AND $N^{15}(p, n)O^{15}$ REACTIONS. C.Wong, J.D.Anderson, S.D.Bloom, J.W.McClure and B.D.Walker.

Phys. Rev. (USA), Vol. 123, No. 2, 598-605 (July 15, 1961).

The angular distribution of the neutrons from the $C^{13}(p, n)N^{13}$ and $N^{15}(p, n)O^{15}$ ground-state reactions was measured in 10° steps from 0° to 150° for incident proton (laboratory) energies of approximately 6.5, 6.9, 7.5, 8.1, 8.6, 8.9, 9.4, 10.6, 11.4, and 12.2 MeV. Additional measurements were made for C^{13} at 5.0, 10.2, 10.9, and 13.3 MeV, and for N^{15} at 5.5, 7.7, 7.8, and 13.6 Me A calibrated plastic or stilbene scintillator was used in order to obtain absolute differential cross-sections. Time-of-flight techniques on the Livermore variable energy cyclotron allowed positi identification of the ground-state neutrons. The targets [CO_2 (58%C^{13}) and N_2 (90%N^{15})] were sufficiently thick to average o the effects of possible compound-nucleus contributions. From preliminary fits to the C^{13} angular distributions, Glendenning and Bloom have inferred an effective neutron–proton interaction insi the nucleus.

11011 $Ca^{40}(p,\gamma)Sc^{41}$ REACTION. J.W.Butler.

Phys. Rev. (USA), Vol. 123, No. 3, 873-7 (Aug. 1, 1961).

Proton capture by Ca^{40} was studied by means of observations both the prompt gamma-rays from resonance states in the compo nucleus and the delayed positrons from the decay of the ground state. Targets of CaO were prepared by the electrodeposition of on to a Pt backing followed by the oxidation of the Ca and the pur of impurities by heat. These targets were bombarded by protons fro 2 MV Van de Graaff accelerator, producing the reaction $Ca^{40}(p,\gamma)$ The gamma-rays from this reaction were observed with the use 3 in. dia. by 3 in. NaI(Tl) crystal and a 256-channel pulse-height analyser. Positrons from the decay of Sc^{41} were detected with th use of a thin plastic phosphor, 1.5 in. dia. by 0.012 in. thick. Tw resonances in the reaction were observed at bombarding energie 650 ± 5 keV and 1850 ± 10 keV. Two other possible resonances were observed at 1550 ± 15 keV and 1630 ± 15 keV. The 650 keV resonance corresponds to an excited state in Sc^{41} at 1.723 ± 0.011 M has an integrated cross-section of 0.02 eV barn (factor of 2 uncertain either way), has a width of less than 5 keV, and involves a gamm

y whose energy was measured to be 1.71 ± 0.03 MeV. The 50 keV resonance corresponds to an excited state in Sc^{41} at 383 ± 0.014 MeV, has an integrated cross-section of 0.3 eV barn actor of 2 uncertainty either way), has a width of less than 10 keV, d involves a gamma-ray whose energy was measured to be 89 ± 0.02 MeV.

11012 ANGULAR DISTRIBUTIONS OF THE REACTIONS $Co^{59}(p,\alpha)Fe^{56}$ AT 7.7-14.1 MeV AND $Mn^{55}(p,\alpha)Cr^{52}$ AT 6-12.9 MeV. H.Ogata, H.Itoh, Y.Masuda, K.Takamatsu, K.Kawashima, A.Masaike and I.Kumabe.
Phys. Soc. Japan, Vol. 15, No. 10, 1726-31 (Oct., 1960).

The angular distributions resulting in the ground and first excited states of the residual nuclei were measured at 7.7, 8.7, 9.8, 10.85, 11.9, 13.1 and 14.1 MeV and at 7.65, 8.85, 9.65, 10.7, 11.8 and 12.9 MeV of the incident proton energy, respectively, making use of proportional counters. Similar behaviour was obtained for these four reactions. For the reaction $Co^{59}(p,\alpha)Fe^{56}$ the forward peak in the angular distribution is prominent at 14.1 and 13.1 MeV and disappears gradually with decreasing proton energy, and the angular distribution is approximately 90° symmetrical below about 11 MeV. For the reaction $Mn^{55}(p,\alpha)Cr^{52}$ the angular distribution is considerably forward peaked at 12.9 and 11.8 MeV and it is approximately 90° symmetrical below about 10 MeV. It was found that the total cross-section integrated from the angular distributions for both reactions decreases smoothly with increasing proton energy. It is considered that the reactions $Co^{59}(p,\alpha)Fe^{56}$ and $Mn^{55}(p,\alpha)Cr^{52}$ resulting in the ground and first excited states of the residual nuclei occur through the similar reaction process, that is, in the lower energy region the compound nucleus process plays a predominant role, although some contribution from the direct interaction process cannot be neglected, and the contribution from the direct interaction process becomes gradually significant with increasing proton energy and it predominant above about 11 MeV.

11013 INTERACTIONS OF 7.5 MeV PROTONS WITH COPPER AND VANADIUM.
J.W.Shore, N.S.Wall and J.W.Irvine, Jr.
Phys. Rev. (USA), Vol. 123, No. 1, 276-83 (July 1, 1961).

The separate cross-sections for interaction of 7.5 MeV protons were measured for natural copper and vanadium. Angular distributions for elastic scattering are presented. The (inelastic scattering + alpha emission) cross-sections are: copper, 266 mb, and vanadium, 134 mb. The (p, n) reaction cross-sections are: Cu^{65}, 537 mb, and V^{51}, 555 mb. These data, along with separate measurements of polarization from copper, are compared with optical-model computations. The results indicate a volume-absorption potential rather than a surface-absorption potential.

11014 MIXING RATIO OF THE 440 keV GAMMA RADIATION IN ^{23}Na. A.Mizobuchi, T.Katoh and J.Ruan.
J. Phys. Soc. Japan, Vol. 15, No. 10, 1737-40 (Oct., 1960).

The angular distribution and the direction-polarization of the 440 keV gamma-rays in the $Na^{23}(p,p'\gamma)Na^{23}$ reaction were measured at the 1.29 MeV resonance. For these measurements the following results were observed; for the angular distribution, $W(\theta) = 1 - (0.091 \pm 0.004)P_2(\cos\theta)$ and for the polarization parameter, $p = +0.69 \pm 0.02$. From the observed results, the mixing ratio of the 440 keV gamma radiation was obtained as $(E2/M1)^{1/2} = +0.045 \pm 0.015$. This value agrees with the prediction from the collective model.

11015 INTERACTIONS OF 1.0, 2.0, AND 3.0 BeV PROTONS WITH Ag and Br IN NUCLEAR EMULSION.
E.W.Baker and S.Katcoff.
Phys. Rev. (USA), Vol. 123, No. 2, 641-6 (July 15, 1961).

Stars produced in insensitive nuclear emulsions by 1.0-3.0 BeV protons were classified into different groups depending on whether light fragments and/or fission fragments are emitted. Alpha-particle spectra and angular distributions are presented for each of the various groups. The probability for light-fragment emission increases rapidly with increasing beam energy up to 2.0 BeV. The angular distribution of the light fragments is peaked forward but also shows a preference for emission at 90° to the beam. Fission events increase from ~3% of the interactions with Ag and Br at 1.0 BeV to ~11% at 3.0 BeV. Ranges and angular distributions are also given for the recoil and fission fragments.

11016 SPALLATION OF URANIUM AND THORIUM NUCLEI WITH BeV-ENERGY PROTONS.
B.D.Pate and A.M.Poskanzer.
Phys. Rev. (USA), Vol. 123, No. 2, 647-54 (July 15, 1961).

Cross-sections were measured for the production of isotopes of uranium, protactinium, thorium, and actinium in the irradiation of U^{238}, U^{235}, and Th^{232} with 0.68 and 1.8 BeV protons. In addition, some yields were determined at other bombarding energies ranging up to 6.2 BeV. Calculations for the cross-sections at 1.8 BeV bombarding energy were made, based on recent Monte Carlo calculations of the knock-on phase of the interaction, combined with published systematics of nuclear evaporation, and several assumptions as to fission-evaporation competition. Even without fission competition the calculated yields are considerably lower than the experimental ones, indicating a failure of the model for the knock-on phase of the reaction to predict sufficient probability for simple processes with low deposition energy. In view of the better agreement with experiment that previous workers have obtained with this type of calculation for 0.34 BeV protons on uranium, it is suggested that the present descrepancy may be due to an overemphasis of meson processes in the proliferation of the knock-on cascade in the calculation.

Due to Neutrons

11017 THEORY OF AVERAGE NEUTRON REACTION CROSS SECTIONS IN THE RESONANCE REGION. P.A.Moldauer.
Phys. Rev. (USA), Vol. 123, No. 3, 968-78 (Aug. 1, 1961).

The scattering matrix for compound nucleus processes is studied in the R-matrix formalism, using a series expansion which is due to Thomas. It is shown that this series generally converges when (a) the average total resonance width is less than the average resonance spacing, (b) the number of important channels is not too large, and (c) the width amplitudes have random signs. The treatment also suggests strongly that the series does not converge in the continuum region. In the region of convergence the exact relationship between the channel transmission factor T_c and the ratio of partial width to level spacing is found, in the absence of direct scattering reactions, to be $T_c = 2\pi\langle\Gamma_{\lambda c}\rangle/D - \pi^2\langle\Gamma_{\lambda c}\rangle^2/D^2$. The quadratic term is shown to be important in the vicinity of optical-model maxima. Correction terms to the Hauser–Feshbach relations for average reaction cross-sections arising from the higher-order terms of the series are obtained and are found to depend on the statistical properties of both resonance widths and resonance spacings. The effect on average neutron inelastic, compound elastic, and capture cross-sections is discussed and an example of a calculation is presented.

GAMMA-RAYS FROM THERMAL NEUTRON CAPTURE.
See Abstr. 11044

11018 MEASUREMENT OF THE CROSS-SECTION FOR SOME NUCLEAR REACTIONS USING 14 MeV, BY AN ACTIVATION METHOD. H.Pollehn and H.Neuert.
Z. Naturforsch. (Germany), Vol. 16a, No. 3, 227-32 (March, 1961). In German.

Measurements were made of the cross-sections for (n, p), (n, α), (n, 2n) and (n, He^3) reactions using 14 MeV neutrons incident on Fe, Al, Cu, Ce and Cs targets using a NaI crystal to identify the radioactive isotopes produced. The results are compared with those of other workers. R.H.Thomas

11019 INTERPRETATION OF EXPERIMENTAL (n,2n) EXCITATION FUNCTIONS.
D.W.Barr, C.I.Browne and J.S.Gilmore.
Phys. Rev. (USA), Vol. 123, No. 3, 859-64 (Aug. 1, 1961).

Radiochemically determined (n,2n) excitation functions for Sc^{45}, Ti^{49}, Ni^{58}, Cu^{65}, Ge^{70}, As^{75}, Sr^{84}, Rb^{85}, Rb^{87}, Y^{89}, Zr^{90}, Sn^{112}, Cd^{114}, Sb^{123}, and U^{238} were interpreted in terms of the statistical model of nuclear reactions. Values of the level density parameter α are obtained and correlated with mass number. A procedure is outlined for predicting the magnitude of any (n,2n) cross-section from the nuclear content of the target material. Two level density formulations are studied, and approximations customarily made in calculations of this sort are examined quantitatively.

11020 NEUTRON TOTAL CROSS SECTIONS OF Be, B^{10}, B, C, AND O. D.B.Fossan, R.L.Walter, W.E.Wilson and H.H.Barschall.
Phys. Rev. (USA), Vol. 123, No. 1, 209-18 (July 1, 1961).

Total cross-sections of Be, B^{10}, B, C, and O were measured for

neutrons of energies between 3.4 and 16 MeV. Neutrons of energy spreads between 15 and 40 keV were produced by bombarding tritium targets with protons or deuterium targets with deuterons, the charged particles being accelerated in a tandem electrostatic accelerator. Sharp peaks in the total cross-sections of B^{11}, C, and O yielded information about energy levels in B^{12}, C^{13}, and O^{17}. None of the total cross-sections of the five nuclei investigated showed sharp peaks above energies corresponding to an excitation energy of the order of 12 MeV of the respective compound nucleus. The transition from sharp structure to a slowly varying cross-section occurs quite abruptly, except for the compound nucleus B^{11} which is excited to almost 12 MeV even for slow neutrons.

11021 CROSS SECTIONS FOR THE (n, 2n) REACTION IN C^{12}, N^{14}, O^{16} AND F^{19} IN THE ENERGY RANGE 10-37 MeV. O.D.Brill', N.A.Vlasov, S.P.Kalinin and L.S.Sokolov.
Dokl. Akad. Nauk SSSR, Vol. 136, No. 1, 55-7 (Jan. 1, 1961).
In Russian.

Neutrons produced from deuterium and tritium targets bombarded by deuterons accelerated to energies up to 20 MeV in a cyclotron were used, and the cross-sections were determined by measuring the activities induced in samples containing the respective elements by the (n, 2n) reaction. The results have fairly large associated errors due to the spread of neutron energies, the difficulty of measuring the incident neutron intensity, and the high background, but the general shapes of the cross-section curves are clearly established. The variation of the C^{12} cross-section with energy does not appear to lead to the known cross-section at 90 MeV unless some complex energy dependence is introduced. The lowness of the cross-sections of C^{12}, N^{14} and O^{16} by comparison with the total inelastic cross-sections of these nuclei is discussed. [English translation in: Soviet Physics — Doklady (USA)].
J.E.Gore

11022 THE STUDY OF (n, p) AND (n, α) REACTIONS IN CsI WITH 12.1 TO 19.6 MeV NEUTRONS.
M.Bormann and R.Langkau.
Z. Naturforsch. (Germany), Vol. 16a, No. 4, 444-5 (April, 1961).
In German.

The cross-sections for (n, p) and (n, α) reactions in a CsI crystal were measured for a number of incident neutron energies. The α-particle spectra were roughly analysed and the contributions to the reactions of statistical evaporation and direct exchange processes estimated. A more complete investigation of these reactions is to be published later. S.J.St-Lorant

11023 DEUTERIUM AND BERYLLIUM (n,2n) CROSS SECTIONS BETWEEN 6 AND 10 MeV. H.C.Catron, M.D.Goldberg, R.W.Hill, J.M.LeBlanc, J.P.Stoering, C.J.Taylor and M.A.Williamson.
Phys. Rev. (USA), Vol. 123, No. 1, 218-20 (July 1, 1961).

The (n,2n) cross-sections of deuterium and beryllium were measured for incident neutron energies in the range from 6 to 10 MeV using a large liquid scintillator. The cross-sections in barns obtained for deuterium were 0.067 ± 0.007 at 6.11 MeV, 0.073 ± 0.007 at 6.55 MeV, 0.088 ± 0.009 at 7.32 MeV, 0.11 ± 0.010 at 8.26 MeV, and 0.14 ± 0.015 at 10.2 MeV. The beryllium cross-sections were 0.55 ± 0.08 at 6.55 MeV, 0.56 ± 0.07 at 7.32 MeV, and 0.63 ± 0.09 at 8.26 MeV.

11024 NEUTRON CAPTURE CROSS-SECTION OF GOLD AT 30 keV and 64 keV. L.W.Weston and W.S.Lyon.
Phys. Rev. (USA), Vol. 123, No. 3, 948-9 (Aug. 1, 1961).

The capture cross-section of gold was measured with kinematically collimated neutrons from the $Li^7(p,n)Be^7$ and $T(p,n)He^3$ reactions. The cross-sections at 30.2 keV and 63.9 keV were found to be 0.767 ± 0.060 and 0.456 ± 0.040 barn, respectively.

11025 ANGULAR DISTRIBUTION OF 2.8 MeV NEUTRONS ELASTICALLY SCATTERED BY Fe, Cu, Zn, Cd, Sn AND Sb NUCLEI. Y.A.Tots'kyi.
Ukrayin. fiz. Zh. Dodatok (USSR), Vol. 3, No. 2, 3-8 (1958).
In Ukrainian.

The measurement methods used and the results obtained are presented. The neutron source was the D(d, n)He^3 reaction. The measurements were made over an angular range from 25° to 140°. Toroidal scatterers were employed. A methane ionization chamber served as the detector.

11026 In^{116} ACTIVATION RATIOS.
M.A.Greenfield and R.L.Koontz.
Phys. Rev. (USA), Vol. 123, No. 1, 197-8 (July 1, 1961).

The data of Domanic and Sailor (Abstr. 13287 of 1960) regarding the ratio of the 54 min to the 13 sec activities of In^{116} product by neutron capture in In^{115} are corrected with experimentally determined self-absorption factors for 54 min In^{116}. The results of these corrections have removed an anomaly observed between foils of different thicknesses, provided the foil is known to have been uniformly activated throughout its volume. The corrections appear to have removed a dependence of the ratio of activities on neutron energies from thermal to 2.66 eV. However, even after correction of the data there remains a substantial difference in the value of the ratio of activities at 3.86 eV. The corrected value of the ratio at 3.86 eV is about one half the value at the other energies investigated.

11027 MULTILEVEL ANALYSIS OF THE TOTAL NEUTRON CROSS SECTION OF Pu^{241} BELOW 12 eV.
O.D.Simpson and M.S.Moore.
Phys. Rev. (USA), Vol. 123, No. 2, 559-64 (July 15, 1961).

Measurements of the total cross-section of Pu^{241} were analysed using a multilevel formula, under the assumption that the observed resonance asymmetries are due to interference in a small number of fission channels. As was the case for U^{233}, the analysis is interpreted as evidence that there are differences in the average fission widths of resonances belonging to the two possible spin states of the compound nucleus.

Due to Mesons and Hyperons

11028 EMISSION OF ^{8}Li, ^{9}Li AND ^{8}B FRAGMENTS FROM STARS PRODUCED BY 4.3 GeV π^--MESONS IN NUCLEAR EMULSION. K.Imaeda, M.Kazuno and N.Ito.
J. Phys. Soc. Japan, Vol. 15, No. 10, 1753-9 (Oct., 1960).

Stars with more than 5 black prongs were examined to study Li^8, Li^9 and B^8 fragments emitted. 90 examples were found of hammer tracks produced by Li^8 or B^8 fragments, 11 examples of tracks produced by $Li^9 \rightarrow Be^8 + e^- \rightarrow He^4 + He^4 + n + e^-$ and the one $Li^9 \rightarrow Be^9 + e^- \rightarrow He^5 + He^4 + e^-$. The experimental result of angular distribution, energy distribution, and frequency of emission of these fragments are given. Comparison is made between the experimental result and the prediction of evaporation theory on the frequency of emission of these fragments. The effect of the B^8 fragments on the estimation of the Coulomb barrier of the residual nucleus for the Li^8 fragment is discussed.

Due to Deuterons

11029 (d,α) REACTIONS ON SOME LIGHT NUCLEI. C.Hu.
J. Phys. Soc. Japan, Vol. 15, No. 10, 1741-52 (Oct., 1960).

Angular distributions of the emergent alpha particles from the reactions $O^{16}(d, \alpha_0)N^{14}(g'nd.)$, $N^{14}(d, \alpha_0)C^{12}(g'nd.)$, $N^{14}(d, \alpha_1)C^{12*}$ (4.44 MeV state), $F^{19}(d, \alpha_0)O^{17}(g'nd.)$, $F^{19}(d, \alpha_1)O^{17*}$(0.872 MeV state) and $P^{31}(d, \alpha_0)Si^{29}(g'nd)$ were investigated at several bombarding energies in the region from 10.3 to 11.4 MeV. The distributions which cover the angular range between approximately 25° and 160° in the centre-of-mass system, exhibit generally oscillatory and forward peaking behaviour. The intensity of the transition to the 2.31 MeV (T = 1) state of N^{14} was measured in the range from 10.5 to 11.4 MeV in the step of 100 keV interval by aluminium absorber. The alpha particles from the targets were detected by a thin CsI(Tl) crystal scintillation spectrometer. The experimental results are compared with the theoretical curves calculated by simplified direct-interaction model of Butler (Abstr. 8973 of 1951) and the model which includes heavy particle stripping process. The attempts to fit some data are also made by using an approximate expression derived by Newns for double stripping process.

11030 SURVEY OF INELASTIC SCATTERING OF DEUTERONS BY HEAVY ELEMENTS. B.L.Cohen and R.E.Price.
Phys. Rev. (USA), Vol. 123, No. 1, 283-94 (July 1, 1961).

Energy spectra of inelastically scattered deuterons from approximately 30 heavy elements are measured with about 80 keV resolution. Many new levels are reported, including a level in Pr whose discovery substantially alters the decay scheme of Nd^{141}. The gross structure of the spectra is studied and several regularities noted. Angular distributions in Zr and the even isotopes of Sn indicate that the parity of the strongest levels in the anomalous peaks (~2.5 MeV) are negative, in agreement with the popular assumption that they are the 3^- collective vibrational level; however, there ar

so several strongly excited positive-parity levels in that region. ie correlation between cross-sections for exciting given levels by ,d') and (d,p) or (d,t) reactions is studied. The correlation efficients are generally slightly negative, but there are several ses where the same levels are strongly excited by all three actions, including one case (in Sn^{117}) where the principal $d_{5/2}$ ngle quasi-particle level is also the principal 2+ vibrational level sed on the $s_{1/2}$ ground state. A very strong positive correlation is und between cross-sections for exciting given levels by Coulomb citation and by direct-interaction inelastic scattering. The large aks reported by Yntema and Zeidman (Abstr. 8607 of 1959) in elastic deuteron scattering from Rh, Ag, and Sn at 4-5 MeV and om Ta and Pt at about 3 MeV were not found; explanations for this e offered.

11031 POLARIZATION IN HEAVY PARTICLE STRIPPING. M.A.Nagarajan.

rogr. theor. Phys. (Japan), Vol. 23, No. 6, 1214-16 (June, 1960).

It is suggested that the polarization from heavy-particle ripping might account for the discrepancy between the observed olarization and that calculated in the direct-stripping model. An xpression for the polarization is derived. I.J.R.Aitchison

11032 STUDY OF THE DIFFERENTIAL CROSS SECTIONS OF DEUTERON STRIPPING REACTIONS AS A UNCTION OF THE INCIDENT ENERGY. E.W.Hamburger.

hys. Rev. (USA), Vol. 123, No. 2, 619-26 (July 15, 1961).

Angular distributions for the reactions $C^{12}(d,p)$ and $O^{16}(d,p)$ to he ground and first excited states of C^{13} and O^{17} were obtained at euteron energies of 10.2, 12.4, and 14.8 MeV. These results and hose of previous experiments at other energies between 3 and 9 MeV are compared with the predictions of the usual plane-wave Born approximation theory, due originally to Butler. The assumption of plane waves leads to the prediction that the differential ross-section is a function of energy and scattering angle only hrough the transfer momentum q: angular distributions at different energies should coincide when plotted versus q. It is found hat this is only approximately true on the main stripping peak of he angular distribution; at larger angles the cross-section is a nore complicated function of energy and angle. Furthermore the tripping peak itself shifts as a function of q, principally in the euteron energy range 10 to 19 MeV.

11033 ISOTOPIC-SPIN SELECTION RULE VIOLATION IN THE B^{10} (d,α) Be^8 REACTION.

J.R.Erskine and C.P.Browne.

Phys. Rev. (USA), Vol. 123, No. 3,958-67 (Aug. 1, 1961).

All previous tests of the isotopic-spin selection rule in (d,α) reactions were obscured by statistical weight factors because in each case the initial and final nuclear states had spin and parity 0^+. The $B^{10}(d,\alpha)$ Be^8 reaction provides a test of the isotopic-spin selection rule free from this restriction. The energy levels of Be^8 near the lowest T = 1 level were studied with the $Li^6(He^3,p)$ Be^8 and Be^9 (He^3,α) Be^8 reactions as well as with the $B^{10}(d,\alpha)$ Be^8 reaction. Energy levels in Be^8 were found at 16.623±0.010 MeV, 16.921±0.010 MeV, and 17.637±0.006 MeV. The widths are 95±20 keV, 85±20 keV, and <15 keV, respectively. The first of these levels is the lowest T = 1 state, whereas the second is T = 0 and the third probably T = 1. Energy levels at 16.08 MeV and a J = 2 level at 17.7 MeV, reported by other laboratories, were not observed. The ratio of the differential cross-sections for formation of the 16.62 and 16.92 MeV levels was measured over a range of angles and bombarding energies. The ratio is about 1.4 and is roughly constant for both the $Li^6(He^3,p)$ Be^8 and $B^{10}(d,\alpha)$ Be^8 reactions. This implies complete violation of the selection rule because the latter reaction should not go to the T = 1 level. Arguments are given which indicate that the T = 0 impurities in the 16.62 MeV T = 1 level are probably quite small. Consequently, the failure of the selection rule probably results from the complete intermixing of T = 0 and T = 1 states in the C^{12} compound nucleus near 28 MeV excitation. Groups from the $C^{12}(He^3,p)$ N^{14} reaction were seen corresponding to levels in N^{14} at 5.691±0.008, 5.834±0.008, 6.203±0.008, and 6.440±0.008 MeV.

Due to Alpha-particles

11034 REACTIONS OF ALPHA PARTICLES WITH IRON-54 AND NICKEL-58. F.S.Houck and J.M.Miller.

Phys. Rev. (USA), Vol. 123, No. 1, 231-40 (July 1, 1961).

The excitation functions for the (α,p), (α,n), (α,pn), $(\alpha,2n)$, $(\alpha,2pn)$, and $(\alpha,p2n)$ reactions of Fe^{54}, and the $(\alpha,\alpha'p)$, $(\alpha,\alpha'n)$, $(\alpha,\alpha'pn)$, and $(\alpha,\alpha'2n)$ reactions of Ni^{58} were determined for α-particle energies up to 40 MeV. A large preference for proton emission is observed. At the maxima in the excitation functions, these ratios were obtained: $\sigma(\alpha,p)/\sigma(\alpha,n) = 3.1$; $\sigma(\alpha,pn)/\sigma(\alpha,2n) = 70$; $\sigma(\alpha,\alpha'p)/\sigma(\alpha,\alpha'n) \approx 6$; $\sigma(\alpha,2pn)/\sigma(\alpha,p2n) = 6.3$ (at 40 MeV); and $\sigma(\alpha,\alpha'pn)/\sigma(\alpha,\alpha'2n) = 140$ (at 40 MeV). These results are discussed in terms of the compound-nucleus model. A value of $r_0 = 1.7$ fermis is required to fit the low-energy portion of the observed "total" cross-section with total reaction cross-section calculated from continuum theory.

11035 PROTONS FROM ALPHA-INDUCED REACTIONS. W.Swenson ans N.Cindro.

Phys. Rev. (USA), Vol. 123, No. 3, 910-22 (Aug. 1, 1961).

The results of proton energy spectra measured at several angles from 30.5 MeV alpha-particle-induced reactions on Al^{27}, V^{51}, Co^{59}, As^{75}, Nb^{93}, Rh^{103}, In^{115}, and Ta^{181} were analysed using the statistical model. The analysis yielded the differential cross-section $d^2\sigma/d\Omega dE$ and the relative level density $\omega(E)$ of the residual nucleus. The nuclear temperature $1/T \equiv d(\ln\omega)/dE$ and the level-density parameter a of $\omega = C\exp[(aE)^{1/2}]$ were obtained. The energy and angular dependence of the spectra are adequately described by the statistical model at back angles, with the indication of the presence of a direct-reaction mechanism contribution at forward angles, which extends to high excitation energies.

11036 THE DIRECT-INTERACTION MECHANISM IN THE REACTION Li^6 (α,d) Be^8.

S.V.Starodubtsev and K.V.Makaryunas

Dokl. Akad. Nauk SSSR, Vol. 129, No. 3, 547-9 (Dec. 21, 1959).

In Russian.

Previous work by other workers has shown that there is a large yield of deuterons from the bombardment of a Li^6 target by 31·5 MeV α particles but the data available does not suffice in favour of a particlar reaction mechanism. Further experiments were carried out to study the reaction mechanism and also to provide information in connection with the α-deuteron model of the Li^6 nucleus. The experimental results all indicate that an important part is played by a process which occurs without the formation of a compound nucleus and the results also seem to indicate the existence in the Li^6 nucleus of a substructure in the form of a deuteron which exists for a certain time. There is also some correspondence between the experimental results and Butler's theory of a knocking out mechanism. [English translation in: Soviet Physics–Doklady, Vol. 4, No. 6, 1292-4 (May-June, 1960)]. B.Brown

11037 ANGULAR CORRELATIONS IN THE REACTIONS $^{18}O(\alpha,n\gamma)^{21}Ne$ AND $^{22}Ne(\alpha,n\gamma)^{25}Mg$.

W.M.Deuchars and D.Dandy.

Proc. Phys. Soc. (GB), Vol. 77, Pt 6, 1197-1204 (June, 1961).

The angular correlation of the gamma-radiation from the first excited state of Ne^{21}, in coincidence with neutrons, was studied using an axially symmetric neutron counter at 0° to the incident beam direction. The results for Ne^{21} together with the published lifetime measurement of the first excited state of Ne^{21}, show that the amplitude of the electric quadrupole radiation divided by the amplitude of the magnetic dipole radiation is $0.004 \leq \delta \leq 0.03$. The gamma-radiation from the first excited state of Mg^{25}, in coincidence with neutrons, was also observed but no detailed study of the angular correlation was made.

11038 YIELD RATIOS FOR THE ISOMERIC PAIR $Sc^{44m,44}$ FORMED IN $(\alpha,\alpha n)$ AND (α,n) REATIONS. S.M.Bailey.

Phys. Rev. (USA), Vol. 123, No. 2, 579-82 (July 15, 1961).

The yield ratio of Sc^{44m}/Sc^{44} was measured in $Sc^{45}(\alpha,\alpha n)Sc^{44}$ reactions with helium ions of energies between 20 and 43 MeV and at 320 MeV. The measured ratio was nearly constant at a value of 1.5 between 20 and 43 MeV and was 0.62 at 320 MeV. The Sc^{44m}/Sc^{44} ratio was measured in $K^{41}(\alpha,n)Sc^{44}$ reactions at 10 and 43 MeV with values of 0.3 and 0.9, respectively. The isomer ratio was calculated for the K^{41}(10 MeV α,n)Sc^{44} reaction by means of a compound-nucleus model, and for the Sc^{45}(320 MeV $\alpha,\alpha n$)Sc^{44} reaction by means of a classical knock-on model. The calculated ratios were 0.32 and 0.51, respectively.

Due to other Particles and Nuclei

11039 ELASTIC SCATTERING OF IDENTICAL SPIN-ZERO NUCLEI. D.A.Bromley, J.A.Kuehner and E.Almqvist.
Phys. Rev. (USA), Vol. 123, No. 3, 878-93 (Aug. 1, 1961).

Elastic scattering measurements were carried out on the $C^{12} + C^{12}$ and $O^{16} + O^{16}$ systems in the energy range from 6 to 35 MeV using heavy-ion beams from the Chalk River tandem accelerator and Au—Si surface barrier detectors. At energies below the Coulomb barriers the Mott scattering predictions are in excellent accord with the measurements as functions of both angle and energy. At energies above the barrier the O + O excitation curve drops exponentially below the Mott predictions to a value of 10 mb/sr at E(c.m.) = 16.5 MeV and remains approximately constant thereafter at that value; in contrast, the C + C excitation curve shows marked resonant interference structure. The states involved have $\tau > \sim 10^{-21}$ sec, large compound elastic brancing ratios Γ_c/Γ, and appear to correspond to resonant absorption of high-order partial waves, hence have high angular momentum. It is suggested that these states reflect a quasi-molecular interaction mechanism which is involved in grazing collisions of these nuclei and which is critically dependent upon the structure of the nuclei involved.

11040 ANGULAR DISTRIBUTION AND RANGES OF N^{13} PARTICLES FROM N^{14} ON N^{14}. K.S.Toth.
Phys. Rev. (USA), Vol. 123, No. 2, 582-8 (July 15, 1961).

The distribution of N^{13} particles from the neutron transfer reaction $N^{14}(N^{14},N^{13})N^{15}$ was investigated from 3.5 to 32° in the laboratory. Range curves for N^{13} particles were obtained from 16 to 32° (laboratory system). Transfers leaving both residual nuclei in their ground states were distinguished from those in which the products are left in excited states. It is found that (1) the ground-state transfer cross-section decreases as the bombarding energy is lowered; (2) of the N^{15} excited states, the first and/or second contribute significantly to the transfer cross-section; (3) for a given bombarding energy the excited-state transfer distribution peaks at an angle larger than that at which the ground-state transfer distribution reaches its maximum; (4) from the ground-state transfer distribution an r_0 of 2.2 fermi can be determined, while the excited-state transfer distribution yields an r_0 of about 1.65 fermi; and (5) the excited-state distributions are more consistent with the tunnelling mechanism of Breit and Ebel than are the ground-state distributions.

11041 PROTON SPECTRA FROM THE NITROGEN BOMBARDMENT OF FLUORINE. C.E.Hunting.
Phys. Rev. (USA), Vol. 123, No. 2, 606-15 (July 15, 1961).

Energy spectra and absolute differential cross-sections of protons from bombardment of F^{19} with 21.4 and 27.4 MeV N^{14} were measured. The energy spectra were analysed in terms of the statistical model with a level density $\exp(E^*/T)$, where E^* is the excitation energy in the residual nucleus of the assumed reaction $F^{19}(N^{14},p)P^{32}$. The nuclear temperature T increased from about 1.9 MeV at 0° to about 2.5 MeV at 145° c.m., but did not vary with bombarding energy. The angular distributions show minima near 90° c.m., with anisotropy increasing as the bombarding energy and proton energy increase. At the lower bombarding energy there is approximate agreement with the Ericson—Strutinski theory of angular-momentum effects in compound-nucleus processes, over the entire observed ranges of angle and proton energy. The fit is consistent with $\sigma \approx 3$ in the nuclear level spin distribution $(2j + 1)\exp[-j(j + 1)/(2\sigma^2)]$. At the higher bombarding energy a considerable excess of protons are emitted into the backward hemisphere, especially at high proton energies, suggesting a direct-interaction mechanism in which the observed proton comes from the F^{19}.

Nuclear Fission

11042 THE TRIPLE SPONTANEOUS FISSION OF Cm^{242}. N.A.Perfilov, Z.I.Solov'eva, R.A.Filov and G.I.Khlebnikov.
Dokl. Akad. Nauk SSSR, Vol. 136, No. 3, 581-2 (Jan. 21, 1961). In Russian.

For abstract, see Abstr. 5944 of 1961. [English translation in: Soviet Physics—Doklady (USA), Vol. 6, No. 1, 57-8 (July, 1961)].

MULTILEVEL ANALYSIS OF THE TOTAL NEUTRON CROSS SECTION OF Pu^{241} BELOW 12 eV. See Abstr. 11027

FISSION OF U AND Th BY 1-2 BeV PROTONS. See Abstr. 11016

FISSION OF Ag AND Br IN NUCLEAR EMULSIONS BY 1-3 B PROTONS. See Abstr. 11015

FISSION PRODUCT YIELDS FROM NEUTRON INDUCED FISSION. See Abstr. 11049

NUCLEAR POWER STUDIES

11043 NUCLEONICS REFERENCE DATA MANUAL.
Nucleonics (USA), Vol. 18, No. 11, 147-210 (Nov., 1960

A compilation of data concerning nuclear reactors, including a comprehensive list of power reactors, a tabulation of mechanica physical and thermal properties of fuel and structural materials and their compatibility, tables of the thermal properties of coolan moderators, shielding and structural materials, a chart of stress distribution equations for various fuel shapes, nomograms for hea transference from core to coolant (assuming a chopped cosine flu distribution) and for conversion of units used in nuclear burn-up calculations and lists of energies and intensities of gamma-rays emitted by reactor materials. Also given (see following abstracts are: thermal neutron cross-section data; neutron self-shielding calculations; data on polymerization of organics; a table of the half-lives, particle emission and decay energies of all known radioactive nuclides; fission product yield and decay data. The compilation also contains conversion tables and a comprehensive bibliography. R.D.Smit

11044 GAMMA-RAYS FROM THERMAL NEUTRON CAPTUR E.Troubetzkoy and H.Goldstein.
Nucleonics (USA), Vol. 18, No. 11, 171-3 (Nov., 1960).

Lists intensities of capture γ-rays in seven energy intervals from 0 to > 9 MeV for over 80 elements and also the energies and relative intensities of discrete γ-rays from 23 elements. Discrepancies between the latest data for relative intensities are indicate R.D.Smit

11045 NEUTRON SELF SHIELDING. P.F.Zweifel.
Nucleonics (USA), Vol. 18, No. 11, 174-5 (Nov., 1960).

A summary of the method of calculating rates of neutron capture in small heavily absorbing samples. Self-shielding factors for simple geometrical shapes are graphed and the approx mations used to treat resonance absorption described. R.D.Smit

11046 STATISTICAL TESTS FOR COUNTING. A.H.Jaffey.
Nucleonics (USA), Vol. 18, No. 11, 180-4 (Nov., 1960).

Statistical methods for estimating errors, data pooling tests for consistency and criteria for rejection of unreliable data, suitable for counting experiments are summarized. R.D.Smit

11047 TABLE OF RADIOACTIVE NUCLIDES. J.F.Stehn.
Nucleonics (USA), Vol. 18, No. 11, 186-97 (Nov., 1960).

Half-lives, particle and γ-energies for all the known nuclides (>1250) are listed. Some 1960 data is included. A supplementary table lists γ-emitters in order of half lives and energy. R.D.Smit

11048 NUCLEAR DATA FOR REACTOR STUDIES. H.H.Baucom, Jr.
Nucleonics (USA), Vol. 18, No. 11, 198-200 (Nov., 1960).

A compilation for all elements including density, nuclei/cm^3, 2200 n/sec cross-sections for capture, absorption and fission, mass attenuation coefficients, diffusion length and diffusion coeffe- cient. R.D.Smit

11049 FISSION PRODUCT YIELDS FROM NEUTRON INDUCED FISSION. S.Katcoff.
Nucleonics (USA), Vol. 18, No. 11, 201-8 (Nov., 1960).

A compilation of the latest data, with references. Tables show the thermal neutron fission yields from U^{233}, U^{235} and Pu^{239}, fission-spectrum neutron yields from U^{235}, Pu^{239}, U^{238} and Th^{232}; 14 MeV neutron yields from U^{235} and U^{238}, and about 80 decay chains of U^{235} fission products. R.D.Smith

1 50 NUCLEONICS REACTOR FILE No. 9. YANKEE REACTOR.

Nu nics (USA), Vol. 19, No. 3, facing p. 59 (March, 1961).

. brief description and summary of operating data. The ea r is a 485 MW(H) 136 MW(E) pressurized light water reactor wit tainless steel fuel pins containing enriched (3.4%) UO_2. The re r started operation in August 1960 and reached 110 MW(E) in uary 1961. R.D.Smith

1 051 THERMAL UTILIZATION FACTOR CALCULATION IN HETEROGENEOUS LATTICES.

V Boffi and V.G.Molinari.

Ei gia nucleare (Italy), Vol. 8, No. 4, 247-54 (April, 1961).

A new formalism is given to solve the equations of the ordinary di sion theory for calculating the thermal utilization factor, f, of a erogeneous lattice, whose elementary cell consists of an ar rary number of different regions. The introduction of a geo- ri ically characteristic quantity leads to a recurrence formula fo ne thermal utilization factor and for the coefficients of the ex tions governing the thermal flux distribution in each region. T was done for both plane and cylindrical geometries.

1 052 THEORETICAL ANALYSIS AND EXPERIMENTAL RESULTS FOR C-H MODERATED ASSEMBLIES.

C Zorzoli.

E gia nucleare (Italy), Vol. 8, No. 4, 255-60 (April, 1961).

A survey is made of the exponential experiments on natural u ium lattices having a hydrogeneous moderator, with particular re ence to organic moderators. Since the measured bucklings fo liphenyl moderated lattices look too high, a comparison is made w the experimental values obtained at CISE on impregnated g hite moderated lattices. The theoretical analysis leads to a c irmation of the presence of a systematic error in the measure- n ts on dyphenyl moderated lattices, which can be shown to be due t e contributions of spurious epithermal neutrons.

1053 RELATIVE WORTH OF CONTROL MATERIALS. J.L.Russell, Jr.

l leonics (USA), Vol. 18, No. 12, 88, 90, 92 (Dec., 1960).

A semiempirical method is given for calculating the effects of onance absorption in control elements in thermal nuclear reactors. "boron-equivalent" of a cadmium covered slab absorber is ned as that surface density of boron which has the same react- y effect. This reactivity effect will then be the same in all asonably thermal" nuclear reactors. The experimental evidence porting the theory and its limitations are discussed.

R.D.Smith

1054 A METHOD FOR COMPARING REACTOR CONTROL MATERIALS.

.Pashos, G.D.Ritland and J.L.Russell, Jr.

cleonics (USA), Vol. 18, No. 12, 94, 96, 98, 100 (Dec., 1960).

A method of relating the surface density of absorber material a slab-type thermal reactor control rod to the reactivity worth l nuclear life of the control rods. R.D.Smith

CRITICAL THICKNESS OF A SLAB IN NEUTRON TRANSPORT-THEORY. See Abstr. 10890

CHEBYSHEV POLYNOMIAL CALCULATION OF THE REACTOR CRITICALITY CONDITION. See Abstr. 10891

11055 A.N.P. H.T.R.E.'S FULFILL TEST GOALS. G.Thornton and B.Blumberg.

Nucleonics (USA), Vol. 19, No. 1, 45-51 (Jan., 1961).

A description of the experiments carried out at Idaho involving direct cycle operation of aircraft turbines using nuclear reactors as heat sources. H.T.R.E-1 was water moderated with a water-cooled core structure. Compressed air from a J-47 turbo-jet engine was heated directly by the Ni—Cr—UO_2 fuel elements as it passed through tubes in the core, piercing the water moderator and then returned to the turbine. HTRE-2 was a modification of HTRE-1. HTRE-3 differs in having hydrided zirconium as a moderator and an air cooled reactor structure. It operated at a power level of 32.4 MW with two J-47 jet engines. HTRE-1 and HTRE-2 operated with a reactor-air exit temperature up to 1380° F, HTRE-3 could operate with a temperature up to 1650° F. Detailed performance data are given for HTRE-1 and HTRE-2.

R.D.Smith

USE OF RING-SHAPED NEUTRON SOURCES IN A RESEARCH REACTOR. See Abstr. 10894

PLASMA CYCLOTRON RADIATION AND FUSION REACTORS. See Abstr. 9618

MEASUREMENTS OF THE PROTON ENERGIES FROM SCEPTRE III. See Abstr. 9619
See Abstr.

(D—D) REACTION PRODUCT VELOCITIES IN SCEPTRE III ACCORDING TO A TWO-GROUP MODEL. See Abstr. 9775

11056 CHEMONUCLEAR REACTORS. Nucleonics (USA), Vol. 19, No. 2, 47-52 (Feb., 1961).

A series of three review articles with a short bibliography. Using nuclear reactors with the fissile fuel in the form of small particles [~ 10μ] or thin films, recoil fission fragments cause ionization in the fluid to be processed. Fixation of nitrogen and synthesis of ethylene glycol or hydrazine are among possible chemical processes which are economically attractive. Types of fuel and the separation of fission products from the product are discussed and the synthesis of ethylene glycol considered in detail.

R.D.Smith

ATOMIC AND MOLECULAR PHYSICS

11057 MAXIMUM OVERLAP ATOMIC AND MOLECULAR ORBITALS. P.G.Lykos and H.N.Schmeising.
J. chem. Phys. (USA), Vol. 35, No. 1, 288-93 (July, 1961).

The eigenvectors of the overlap matrix are shown to be maximum overlap orbitals (MO—O's). Naive MO methods, such as that due to Hückel, are shown often to reduce to the MO—O problem. The potential usefulness of MO—O's in the determination of atomic hybrid orbitals and as starting orbitals for SCF calculations is considered.

11058 SPIN—ORBIT INTERACTIONS IN f^n ELECTRON CONFIGURATIONS. B.G.Wybourne.
J. chem. Phys. (USA), Vol. 35, No. 1, 334-9 (July, 1961).

Simple relationships can be shown to exist between the spin—orbit matrix elements of different f^n electron configurations. These relationships allow a great reduction in the labour of calculating the spin—orbit interaction matrices for f^n electron configurations. Several examples are given.

11059 ELECTROSTATIC ENERGY MATRICES OF THE f^5 AND f^6 CONFIGURATIONS. B.G.Wybourne.
J. chem. Phys. (USA), Vol. 35, No. 1, 340-52 (July, 1961).

The electrostatic energy matrices of f^5 and f^6 electron configurations are calculated by the Racah methods. Checking rules are used for all the diagonal matrix elements and certain of the nondiagonal matrix elements.

ATOMS

11060 ANALYTIC HARTREE—FOCK WAVE FUNCTIONS FOR THE 3p-SHELL ATOMS. R.E.Watson and A.J.Freeman.
Phys. Rev. (USA), Vol. 123, No. 2, 521-6 (July 15, 1961).

Hartree—Fock wave-functions were obtained for the 3p-row atoms, i.e. for neutral Al, Si, P, S, Cl, and Ar, and for Cl^-. Solutions were determined in analytic form using a version of Nesbet's symmetry and equivalence restrictions to simplify the calculations for atoms with both closed and unclosed shells of the same l value. These restrictions, the reason for their use, and their relation to other open-shell methods are discussed and the calculated one-electron wave-functions and their eigenvalues are presented.

11061 ON THE GENERALIZED HARTREE AND FOCK METHODS. Ya.I.Vizbaraite, T.D.Strotskite and A.P.Yutsis.
Dokl. Akad. Nauk SSSR, Vol. 135, No. 6, 1358-60 (Dec. 21, 1960). In Russian.

For abstract, see Abstr. 4895 of 1961. [English translation in: Soviet Physics—Doklady (USA), Vol. 5, No. 6, 1300-2 (May-June, 1961)].

11062 THOMAS—FERMI—DIRAC MODEL OF COMPRESSED IONS. S.Kobayashi.
J. Phys. Soc. Japan, Vol. 15, No. 10, 1842-4 (Oct., 1960).

The Thomas—Fermi—Dirac (TFD) method is extended anew to ions in the compressed state and the series expansion coefficients of its TFD function near the boundary are given.

11063 STATISTICAL ELECTRON DENSITY DISTRIBUTIONS AND THOMAS—FERMI—DIRAC SCREENING FUNCTIONS FOR NEUTRAL ATOMS. A.A.Abrahamson.
Phys. Rev. (USA), Vol.123, No. 2, 538-43 (July 15, 1961).

Statistical electron density distributions and Thomas—Fermi—Dirac (TFD) screening functions were obtained for the 104 elements corresponding to integral atomic numbers Z = 2 to Z = 105, for 117 values of radial distance from the atomic centre in each case. These results were calculated, in part, by using Thomas' solutions of the TFD equation in terms of the statistical electron distributions for non-integral values of Z and Jensen's boundary conditions. Values for argon and copper are given here. The complete set of tables for all 104 elements was deposited with the American Documentation Institute Auxiliary Publications Project.

11064 HYPERFINE STRUCTURE OF THE LEVEL $5^2P_{1/2}$ OF POTASSIUM 39. W.N.Fox and G.W.Series.
Proc. Phys. Soc. (GB), Vol. 77, Pt 6, 1141-6 (June. 1961).

The hyperfine structure of the level $5^2P_{1/2}$ of potassium 39 was measured by the techniques of optical—radiofrequency double re
ance. The magnetic interaction constant $a_{1/2}$ was found to be 8.99 ± 0.15 Mc/s, which leads to the value 4.56 ± 0.3 for the rat $a_{1/2}/a_{3/2}$. This is significantly lower than the value 5.08 which t Goudsmit—Fermi—Segrè theory would predict. The measured value of the Landé g-factor is 0.665 ± 0.003.

11065 HYPERFINE STRUCTURE OF THE $(5p)^5(6s)\,^3P_2$ STAT OF $_{54}Xe^{129}$ AND $_{54}Xe^{131}$. W.L.Faust and M.N.McDerm
Phys. Rev. (USA), Vol. 123, No. 1, 198-204 (July 1, 1961).

The hyperfine structures of the metastable $(5p)^5(6s)\,^3P_2$ stat Xe^{129} and Xe^{131} were measured by the atomic-beam magnetic-re ance method. The zero magnetic field intervals $f(F \leftrightarrow F')$ are: for Xe^{129}, $f(\frac{3}{2} \leftrightarrow \frac{5}{2})$ = 5961.2577(9) Mc/s; and for Xe^{131}, $f(\frac{5}{2} \leftrightarrow \frac{7}{2})$ = = 2693.6234(7) Mc/s, $f(\frac{3}{2} \leftrightarrow \frac{5}{2})$ = 1608.3475(8) Mc/s, and $f(\frac{1}{2} \leftrightarrow \frac{3}{2})$ = 838.7636(4) Mc/s. The values of the quadrupole and octupole moments of Xe^{131}, without polarization corrections and without corrections for any effects of configuration mixing, are Q = −0.120(and Ω = +0.048(12) nmb. The hyperfine structure anomaly for th two isotopes due to the $s_{1/2}$ electron alone is $\Delta(s_{1/2})$ = +0.0440(4 in disagreement with the prediction of the single-particle model

11066 COLLISION BROADENING IN THE ARGON SPECTR W.R.Hindmarsh and K.A.Thomas.
Proc. Phys. Soc. (GB), Vol. 77, Pt 6, 1193-6 (June, 1961).

High-resolution photographs of the near infrared spectrum o argon discharge at various pressures revealed that lines whose lower levels are connected by resonance transitions to the groun state suffered markedly greater collision broadening than those whose lower levels are metastable. The excessive broadening o the former group of lines is believed to be due to resonance coll broadening of their lower levels. The collision broadening of on line from each group, namely $1s_2$—$2p_2$, λ8264 A and $1s_5$—$2p_2$, λ69 was measured. The half-intensity collision width of λ8264 was $14.7 \pm 1.0 \times 10^{-20}$ cm^{-1} per atom per cm^3 of argon, while that of λ6965 was $2.0 \pm 0.3 \times 10^{-20}$ cm^{-1} per atom per cm^3 of argon. Th ratio of collision width to collision shift (the latter being taken fr Hindmarsh and Thomas, see Abstr. 6707 of 1959) was 3.1 ± 0.8. This is in agreement with the value 2.75 predicted by the Lindhol theory for interaction due to van der Waals forces between the at The resonance broadening of λ8264 is related to the f-value of th argon resonance line $1p_0$—$1s_2$, λ1048, and this is found to be f = 0.13 ± 0.03, in agreement with calculations quoted by Knox (A 4361 of 1958).

11067 MICROWAVE ZEEMAN SPECTRUM OF ATOMIC FLUORINE.
H.E.Radford, V.W.Hughes and V.Beltran-Lopez.
Phys. Rev. (USA), Vol. 123, No. 1, 153-60 (July 1, 1961).

A paramagnetic resonance absorption spectrum was observe in the products of a radiofrequency electrodeless discharge in fluorine gas. The spectrum consists of eight lines, widely space over a magnetic field range 2000-6000 G, which can be identified with $\Delta M_F = \pm 1$ transitions in the ground $^2P_{3/2}$ level of the F^{19} at Analysis of the spectrum yields $-g_J(F;{}^2P_{3/2})/g_p$ = 438.4839 ± 0.00 $\Delta\nu(F;{}^2P_{3/2})$ = 4020.01 ± 0.02 Mc/s, $-a'''(F;{}^2P)/h$ = 446 ± 10 Mc/ where a''' is the coupling of the off-diagonal hyperfine interactio in the ^2P term and g_p is the g-factor of protons in a cylindrical sample of mineral oil.

11068 MICROWAVE ZEEMAN SPECTRUM OF ATOMIC CHLORINE. V.Beltran-Lopez and H.G.Robinson.
Phys. Rev. (USA), Vol. 123, No. 1, 161-6 (July 1, 1961).

The microwave spectrum of atomic chlorine was observed at 9190 Mc/s in the products of an r.f. electrodeless discharge. Of the twelve allowed transitions per isotope, $\Delta M_I = 0$, $\Delta M = \pm 1$, fi arising from Cl^{35} and two from Cl^{37} were measured. Using a non relativistic Hamiltonian, analysis of the data yields $-g_J(Cl;{}^2P_{3/2})/g_p$ = 438.50415 ± 0.00063, where g_p is the proton gyromagnetic ratio in a cylindrical sample of mineral oil. This result can be transformed to $g_J(Cl;{}^2P_{3/2})/g_J(D)$ = 0.666201 ± 0.0 A calculation of the $g_J(Cl)$-isotope effect shows that it should not observable in the present experiment. Estimates of the atom—at and atom—molecule hard-sphere collision cross-sections are ma from measurements of linewidth and line intensity.

11069 FREE–FREE CONTINUUM OF NITROGEN.
R.G.Breene, Jr and M.C.Nardone.
J. Opt. Soc. Amer., Vol. 51, No. 6, 692 (June, 1961).
The results of applying a method of calculating the free–free continuum in the presence of neutral atoms, see Breene and Nardone (Abstr. 20587 of 1960) to nitrogen is given together with a brief discussion. The plot of cross-section for wavelengths between 4000 and 30 000 A also contains the results for oxygen.
G.H.C.Freeman

11070 INFRARED SPECTRA OF NITROGEN, ARGON, AND HELIUM PLASMAJETS.
R. Tourin, P.M.Henry and E.T.Liang.
J. Opt. Soc. Amer., Vol. 51, No. 7, 800-1 (July, 1961).
Graphs show typical nitrogen emission spectra from 0.5 to 5 μ, and argon and helium spectra from 0.5 to 5μ. Absorptance measurements were also made, and deduced plasmajet temperatures are tabulated. L.M.Roberts

11071 EMISSION SPECTRA OF THE DOUBLY AND TRIPLY IONIZED RARE EARTHS.
G.Dieke, H.M.Crosswhite and B.Dunn.
J. Opt. Soc. Amer., Vol. 51, No. 8, 820-7 (Aug., 1961).
The spectra of the rare earths were photographed under controlled excitation so that either the spectra of the doubly or triply ionized elements are brought out with maximum intensity. A third excitation is used in addition to give the first and second spectra for comparison. Some regularities are immediately apparent and vary very gradually through the rare-earth group. The general features of the spectra are discussed in this paper.

11072 OSCILLATOR STRENGTHS OF NEUTRAL AND IONIZED TITANIUM FROM A VORTEX-STABILIZED ARC. J.B.Tatum.
Monthly Nat. Roy. Astron. Soc. (GB), Vol. 122, No. 4, 311-24 (1961).
Relative oscillator strengths of 200 lines of Ti I and Ti II were measured from spectra of a vortex-stabilized arc running in titanium tetrachloride at 10 080°K. Comparison is made between the present measurements and those of other workers; these data are summarized on a scale which is approximately absolute. It is shown that the case of titanium that the excitation potential effect discovered by Allen and Asaad [Monthly Not. Roy. Astron. Soc. (GB), Vol. 115, 773 (1951)] is merely a selection effect.

Kr^{86} AND ATOMIC-BEAM-EMITTED Hg^{196} WAVELENGTHS. See Abstr. 10464

EFFECT OF LONGITUDINAL PLASMA OSCILLATIONS ON ATOMIC SPECTRA. See Abstr. 10696

11073 ON OPTICAL PUMPING IN GASES.
H.Kopfermann.
Heidelberg. Akad. Wiss. (Math. Nat. Kl.) (Germany), 1960, No. 3, 1-85. In German.
A review of the results achieved by optical pumping methods from the viewpoint of the spectroscopist. Questions discussed include the verification of behaviour of the ground levels, spin and change measurements, excited states especially lifetimes and nuclear quadrupole moments. A.H.W.Beck

11074 CESIUM TRANSITION PROBABILITIES FOR OPTICAL PUMPING. W.B.Hawkins.
Phys. Rev. (USA), Vol. 123, No. 2, 544-7 (July 15, 1961).
Optical transition probabilities are presented between the several magnetic sublevels of the Cs^{133} ground state via the first excited state, given separately for the two fine-structure components. Graphs of the populations of representative states are presented as a function of the time the atoms are illuminated, and a table is given of the populations of atoms absorbing integral numbers of photons from both D lines simultaneously, both polarized and unpolarized.

11075 PRACTICAL DIFFERENTIAL FILTER FOR OPTICAL PUMPING WITH SODIUM LIGHT.
R.Carver, F.R.Lewis,Jr, R.E.Pollock and G.Schrank.
Rev. sci. Instrum. (USA), Vol. 32, No. 7, 861-2 (July, 1961).
The intensity of the D_2 sodium line was reduced relative to that of the D_1 line by taking advantage of the greater Zeeman splitting of the innermost components of the latter. Using an absorption cell of sodium vapour in a field of about 3000 gauss, it was possible to achieve 50% or greater transmission at the perturbed D_1 frequency, while attenuating the unpertubed D_1 frequency by better than an order of magnitude. The intensity ratio D_1/D_2 in the transmitted light could be made as high as 18; higher values are predicted with higher fields and cell temperatures. The experimental arrangement is described.
J.Sheridan

11076 TRANSFER MECHANISMS OF ELECTRONIC EXCITATION (10th SPIERS MEMORIAL LECTURE).
T.Förster.
Disc. Faraday Soc. (GB), No. 27, 7-17 (1959).
"Energy transfer" Discussion, Nottingham, 1959 (see Abstr. 4920 of 1961). This review paper discusses the mechanisms of non-radiative transfer of electronic excitation energy between atoms or molecules. Long-range dipole–dipole transfer is considered in detail. 63 references. J.B.Birks

11077 EXCITATION OF H 2s ELECTRON IMPACT.
D.G.Hummer and M.J.Seaton.
Phys. Rev. Letters (USA), Vol. 6, No. 9, 471-2 (May 1, 1961).
It is argued that the experimental results of Lichten and Schultz [Abstr. 2717 of 1960] and of Stebbings, Fite, Hummer and Brackmann (Abstr. 17689 of 1960) are, in fact, consistent with each other, and with the most recent theoretical work, allowing for exchange and coupling to 2p. M.R.C.McDowell

11078 PHOTOELECTRIC EFFECT AND PAIR ANNIHILATION WITH LARGE MOMENTUM TRANSFER. D.S.Moroi.
Phys. Rev. (USA), Vol. 123, No. 1, 167-74 (July 1, 1961).
Photoelectric effect and pair annihilation in hydrogen with large momentum transfer are studied, taking into account the recoil and anomalous magnetic moment of proton, in an effort to see whether these processes can be used to probe quantum electrodynamics at small distances. A negative result is obtained. It turns out that for an incident energy of 100 MeV the important term containing the electron propagator, which is sensitive to small-distance modifications, is about 0.5% of the term, which is insensitive to them. The proton structure is described by two covariant form factors determined by the electron–proton scattering. The differential cross-sections are calculated in the Born approximation in the laboratory system, neglecting the binding energy of the hydrogen atom. The results are analysed in the extreme relativistic energy range and in the special case that the outgoing electron (photon) comes off perpendicular to the incident beam. The total cross-sections are calculated in the high-energy approximation simply to check the present method of calculations. The differential cross-sections are very small, $\sim 10^{-42}$–10^{40} cm^2/sr. The same calculations if applied to an atom with higher atomic number Z, give the differential cross-sections for the above processes larger by a factor $2Z^5$, if one neglects screening. For a Au target the differential cross-sections are then of the order of 10^{-33}–10^{-31} cm^2/sr. However, this extension of the calculations introduces a considerable error in the differential cross-sections, because the influences of the Coulomb field and anomalous magnetic moment of a nucleus to the electron wave-functions are neglected. It will serve only as an estimate of the order of magnitude of the differential cross-sections.

11079 LOW-ENERGY ELECTRON SCATTERING FROM ATOMIC OXYGEN.
R.H.Neynaber, L.L.Marino, E.W.Rothe and S.M.Trujillo.
Phys. Rev. (USA), Vol. 123, No. 1, 148-52 (July 1, 1961).
The total cross-section for the scattering of electrons by atomic oxygen was measured as a function of electron energy from 2.3 to 11.6 eV. The number of electrons scattered from a region defined by the intersection of an electron beam and a modulated molecular oxygen beam was compared with the number scattered when the oxygen beam was partially dissociated. A radiofrequency discharge dissociated about 30% of the molecules. The degree of dissociation was measured with a mass spectrometer. From the data, the ratios of atomic to molecular scattering cross-sections were obtained. The absolute atomic values were calculated by multiplying these ratios by the molecular oxygen cross-sections obtained by Brüche (1927). The result is a virtually constant cross-section of $(6.2 \pm 0.5)\pi a_0^2$ in the entire energy range studied. This result is compared with five theoretical estimates.

11080 EFFECT OF VIRTUAL EXCITATIONS ON THE ELASTIC SCATTERING OF ELECTRONS AND POSITRONS BY ATOMIC HYDROGEN. K.Smith and P.G.Burke.
Phys. Rev. (USA), Vol. 123, No. 1, 174-8 (July 1, 1961).
Total elastic cross-sections for the scattering of electrons and positrons (neglecting positronium formation) from the 1s state of atomic hydrogen are calculated allowing for virtual excitation to the 2s and 3s states. The S-, P-, and D-wave contributions to Q_{1S-1S} are computed for incident energies below 10 eV. The results for positron scattering show that virtual excitation to the 2s and 3s

states only slightly affects the phase shifts calculated in the static approximation. The influence of the 2s state appears to be much more important for electrons. The scattering lengths of these exploratory calculations are compared with the results of other calculations.

11081 CALCULATION OF THE CHARACTERISTICS OF INELASTIC SCATTERING OF MEDIUM-ENERGY ELECTRONS. A.N.Pilyankevich.
Zh. tekh. Fiz. (USSR), Vol. 31, No. 2, 224-30 (Feb., 1961). In Russian.

For abstract, see Abstr. 5979 of 1961. [English translation in: Soviet Physics—Technical Physics (USA), Vol. 6, No. 2, 161-5 (Aug., 1961)].

11082 ATOMIC BEAM RESONANCE EXPERIMENTS WITH STORED BEAMS.
H.M.Goldenberg, D.Kleppner and N.F.Ramsey.
Phys. Rev. (USA), Vol. 123, No. 2, 530-7 (July 15, 1961).

The atomic-beam separated, oscillatory-field resonance technique was used to study the hyperfine frequency of caesium which is perturbed by collisions with storage box walls. With a wall coating of long straight-chain saturated hydrocarbons, resonances are observed after as many as 200 wall collisions. A theory of the effect of wall collisions on the hyperfine frequency which is in qualitative agreement with experimental results is described. The shape of the resonance curve is analysed by a detailed consideration of the statistical nature of the wall collision.

11083 DISPERSION OF GYROMAGNETIC RATIOS IN COMPLEX SPECTRA. N.Rosenzweig and C.E.Porter.
Phys. Rev. (USA), Vol. 123, No. 3, 853-5 (Aug. 1, 1961).

It is pointed out that random-matrix hypothesis, which was previously used to explain the "repulsion" of energy levels in complex atomic and nuclear spectra, leads to a dispersion in the values of the gyromagnetic ratios which depends on the relative strengths of central and spin-dependent interactions and the number of states which interact with one another in the LS coupling scheme. The dispersion based on experimentally known atomic g factors is computed in three regions of the periodic table, and the empirical trends are found to be on qualitative agreement with the theoretical analysis.

Isotopes

11084 UNDISCOVERED ISOTOPES OF LIGHT NUCLEI. A.I.Baz', V.I.Gol'danskii and Ya.B.Zel'dovich.
Uspekhi fiz. Nauk (USSR), Vol. 72, No. 2, 211-34 (Oct., 1960). In Russian.

An analysis of the available data shows that in the region of light nuclei there should exist hundreds of as yet undiscovered isotopes, stable with respect to heavy particle emission. A summary is given of the main properties of isotopes whose existence is conjectured. In conclusion, the general question of the limits of stability of nuclei is discussed. [English translation in: Soviet Physics - Uspekhi (USA), Vol. 3, No. 5, 729-42 (March-April, 1961)].
J.D.Dowell

MOLECULES

11085 MOLECULES AND MOLECULAR AND ATOMIC COMPLEXES AS GUIDES OF ELECTRONIC WAVES.
A.P.Komar and A.A.Komar.
Zh. tekh. Fiz. (USSR), Vol. 31, No. 2, 231-7 (Feb., 1961). In Russian.

For Abstract, see Abstr. 5989 of 1961. [English translation in: Soviet Physics—Technical Physics (USA), Vol. 6, No. 2, 166-70 (Aug., 1961)].

11086 POTENTIAL FUNCTIONS OF MOLECULES OF THE SERIES $(CH_3)_n SiCl_{4-n}$ (n = 1 – 4). I.F.Kovalev.
Dokl. Akad. Nauk SSSR, Vol. 136, No. 6, 1313-16 (Feb. 21, 1961). In Russian.

For abstract, see Abstr. 9923 of 1961. [English translation in: Soviet Physics - Doklady (USA), Vol. 6, No. 2, 146-9 (Aug., 1961)].

11087 INTERACTION ENERGY IN THE AMALDI–FERMI THEORY FOR A PAIR OF SIMPLE NEGATIVE IONS OF THE SAME KIND WITH FILLED ELECTRONIC SHELLS.
T.Tietz.
J. chem. Phys. (USA), Vol. 34, No. 5, 1848-9 (May, 1961).

A formula is presented for the interaction energy as a functi of internuclear separation in terms of the atomic number and the Thomas–Fermi function for neutral atoms. M.R.C.McDow

11088 BINDING ENERGIES OF ALKALI HALIDE MOLECULES.
G.M.Rothberg.
J. chem. Phys. (USA), Vol. 34, No. 6, 2069-78 (June, 1961).

The repulsive part of the energy of interaction of an alkali io and a halogen ion may be written $fe^{-z/r}$, where f and r are const appropriate to the ions and z is the internuclear distance. In alk halide crystals and monomers, f and r may be determined empirically, but in the case of the dimers the necessary data are lacking. In this paper the repulsive energy is examined qualitati with use of the Thomas–Fermi model, and an approximation is found for the dimer constants that enables accurate calculations t be made of the binding energies of the dimers.

11089 EFFECT OF PRESSURE ON THE ELECTRONIC ABSORPTION SPECTRA OF FERROCENE AND FERRICINIUM ION. J.C.Zahner and H.G.Drickamer.
J. chem. Phys. (USA), Vol. 35, No. 1, 375-6 (July, 1961).

The effect of pressure on the 24 000 cm^{-1} band is to cause a blue shift. This band is assigned to a $3d \rightarrow 4p_z$ transition. The 16 000 cm^{-1} band in ferricinium fluosilicate is shown to experienc a red shift with increasing pressure. T.E.Peaco

11090 VIBRATIONAL RELAXATION IN CARBON DIOXIDE. W.J.Witteman.
J. chem. Phys. (USA), Vol. 35, No. 1, 1-9 (July, 1961).

The vibrational excitation of a CO_2 molecule in collision with another CO_2 molecule is investigated. A derivation of the cross-section by means of the method of the distorted waves and the rate of total energy transfer are presented. There are two relaxation processes with different relaxation times related to direct excitati of the bending mode and excitation in series of the valence mode. Experimental results obtained by the author, to be published separately, confirm this conclusion. The experimental relaxation time for the bending vibration was about one-half of the calculated value, which may be considered a fair agreement in view of the uncertainty involved in the interaction potential and of other approximations which had to be introduced into the calculations.

11091 INTERNAL ROTATION OF cis 2,3-EPOXYBUTANE FROM THE MICROWAVE SPECTRUM. M.L.Sage.
J. chem. Phys. (USA), Vol. 35, No. 1, 142-8 (July, 1961).

The spectrum was investigated in the region from 8000 to 29 000 Mc/s; it consists of singlets and triplets. The ground torsional state shows a pseudo rigid-rotor spectrum with rotation constants 8057.71, 4461.36, and 3468.60 Mc/s. The triplets yield a barrier to internal rotation of 1607 ± 150 cal/mole independent of a range of assumptions concerning the coupling of the two meth groups. The dipole moment was found to be 2.03 ± 0.02D with 2.01 ± 0.02D in the plane of the ring. A group theoretical discussion of double rotors with one rotor on each side of a plane of symmetry is given.

11092 PRESENT STATUS OF THE STUDY OF MEAN AMPLITUDES OF VIBRATION. S.J.Cyvin.
K. Norske Vidensk. Selsk. Skr. (Norway), 1959, No. 2, 15 pp. (publ 1960).

A valuable review (66 references) in which mean amplitudes of vibration obtained from electron diffraction are compared with those obtained from spectroscopic data. Lists of molecules for which mean amplitudes have been computed, together with values i angstroms, are included. W.J.Orville-Thom

11093 VARIATION OF THE INTENSITY OF THE METHYL SYMMETRICAL BENDING VIBRATION IN PARAFFIN
M.R.Basila and G.F.Crable.
J. chem. Phys. (USA), Vol. 35, No. 1, 306-10 (July, 1961).

The integrated infrared absorption coefficients of the methyl C–H symmetrical bending vibration of a number of normal and branched paraffins were studied. Several approaches to the corre lation of intensity variations with structure are discussed and evaluated in terms of the experimental data. The conclusions are (a) the intensities of the branched and normal paraffins must be treated as two distinct classes, and (b) the branched paraffin grou

nsities must be further broken down into three types: (1) methyl ps adjacent to a tertiary or quaternary carbon atom having no r methyl groups directly adjacent, (2) methyl groups adjacent ertiary or quaternary carbon atoms having other adjacent hyl groups directly attached, and (3) methyl groups at the ends ranches or chains of two or more carbon atoms in length. grated absorption coefficients are given for each type of group approximate C–H bond moments are calculated from these ues.

11094 SURFACE-CATALYZED EXCITATIONS IN THE OXYGEN SYSTEM. G.Mannella and P.Harteck.
hem. Phys. (USA), Vol. 34, No. 6, 2177-80 (June, 1961).

A luminosity is produced over Ni maintained at approximately C in a stream of O atoms. Spectroscopic investigation shows the ongly forbidden $b\,^1\Sigma_g^+ - X\,^3\Sigma_g^-$ atmospheric system and $\Sigma_u^+ - X^3\Sigma_g^-$ Herzberg system of the O_2 molecule plus four strong ds of the (0, 0) band of the OH $A\,^2\Sigma - X\,^2\Pi$ interaction. Certain ctral features in the region of the (0, 0) atmospheric band could be resolved for positive identification but are suggested to be vibrational-rotational bands of OH. The Herzberg and atmoeric bands appear to be primary products of the surface catalysis ile the OH molecule can be either a surface product or the result chemical reactions to certain excited species present.

11095 RELATIVE INTENSITIES IN THE TRIPLET SYSTEM OF THE CO BANDS. N.L.Singh and D.C.Jain.
oc. Phys. Soc. (GB), Vol. 77, Pt 3, 817-18 (March, 1961).

Values for the overlap integrals and relative intensities, I, in triplet system of CO bands were calculated by the method of merical integration using Morse wave functions. The values for re compared with those obtained by Pillow and Rowlatt using the istortion method" (Abstr. 9812 of 1960). W.J.Orville-Thomas

11096 MICROWAVE SPECTRUM OF METHYL NITRATE. W.B.Dixon and E.B.Wilson, Jr.
chem. Phys. (USA), Vol. 35, No. 1, 191-8 (July, 1961).

The ground-state rotational constants of methyl nitrate show at the five heavy nuclei of the molecule lie in the same plane. ie hydrogen atoms of the methyl group are found to be staggered th respect to the nearest oxygen of the NO_2 group. Stark effect easurements yield a dipole moment of 3.10 ± 0.05 D. Satellites ising from excited states of the torsion of the NO_2 group were served. Rough relative intensity measurements yield a frequency 130 ± 20 cm^{-1} for this normal mode and a barrier of 00 ± 2600 cal/mole. This would seem to indicate a significant nount of double-bond character in the CO–N bond. The barrier to ternal rotation of the methyl group, as determined from torsional tellite splittings, is 2321 cal/mole. A large discrepancy exists tween the experimental and statistical entropies, the reason for hich is not clear. Satellites arising from the combination first xcited states of the methyl and NO_2 torsions have an anomalous ppearance on the basis of the single internal rotor theory. A ualitative explanation for this is obtained when the theory is xtended to include the torsion of the NO_2 group.

11097 SPECTRAL EMISSIVITIES OF HOT CO_2-H_2O MIXTURES IN THE 2.7 μ REGION. R.H.Tourin.
. Opt. Soc. Amer., Vol. 51, No. 7, 799-800 (July, 1961).

Measured emissivities are compared with those calculated, by Beer's law, from the separately-measured emissivities of H_2O and CO_2. The agreement is within experimental error (± 1%), hus justifying the use of Beer's law even though the H_2O spectrum s not continuous. The relative proportions of H_2O and CO_2 were he same as in a propane–air flame, the spectrum of which is also iven and is qualitatively the same. Mixtures of other gases with CO_2 should behave similarly. L.M.Roberts

11098 THE TiO BAND AT 10025 A. A.V.Pettersson and B.Lindgren.
Naturwissenschaften (Germany), Vol. 48, No. 5, 128-9 (1961). In German.

A rotational analysis of the band (ν_0 = 9965.1 cm^{-1}) has been carried out. It is the 1–0 band of the system $b\,^1\pi - d\,^1\Sigma$. R.F.Barrow

11099 POLARIZATION MEASUREMENTS OF THE ABSORPTION SPECTRUM OF METHYLENE-BLUE. J.Kern and F.Dörr.
Z. Naturforsch. (Germany), Vol. 16a, No. 4, 363-6 (April, 1961). In German.

Methylene-blue was adsorbed onto polyvinyl alcohol film, which was then stretched to orient the molecules. Nine bands were found in the range 2000-6000 A and were measured with the electric vector parallel and perpendicular to the stretched direction. Four of the bands form a Rydberg series. The spectrum is discussed in relation to those of the carotenes. G.F.Lothian

11100 ULTRAVIOLET ABSORPTION SPECTRUM OF AMMONIA IN SOLID ARGON AT 4.2°K. K.Dressler.
J. chem. Phys. (USA), Vol. 35, No. 1, 165-9 (July, 1961).

A series of absorption bands in the region 1600 to 1900 A was observed in thin films of solid argon containing between 0.3% and 3% of ammonia. The bands are attributed to isolated NH_3, and the absence of alternating bands in the observed vibrational progression shows that in the ground state only the J = 0 level is appreciably populated. Thermal equilibration of NH_3 at 4.2°K involves the interconversion of nuclear spin species. It is suggested that the observed rapid equilibration is due to coupling between the proton spins and the spin of the nitrogen nucleus.

11101 MgH AND MgD BANDS AT 2819 A AND 2702 A. M.Aslam Khan.
Proc. Phys. Soc. (GB), Vol. 77, Pt 6, 1133-40 (June, 1961).

During an investigation of the spectra of metallic hydrides of group II of the periodic table, five new bands of MgH at λλ2819, 2702, 2172, 2100 and 2088, a band system of ZnH at 2426 A and a band system of CdH at 2483 A, were observed and analysed. Also the corresponding deuteride bands, where possible, were observed. Only the MgH and the corresponding MgD bands at 2819 A and 2702 A are dealt with in this paper. They are classified as $E^2\Sigma \rightarrow X^2\Sigma$ and $F^2\Sigma \rightarrow X^2\Sigma$ transitions respectively. The rotational constants are calculated as follows:

MgH

$E^2\Sigma \rightarrow X^2\Sigma(0,0)$ band at 2819 A: $B_v' = 6.08\ cm^{-1}$, $D_v' = 3.31 \times 10^{-4}\ cm^{-1}$; $B_v'' = 5.73\ cm^{-1}$, $D_v'' = 3.43 \times 10^{-4}\ cm^{-1}$; $\nu_0 = 35\,550.61\ cm^{-1}$.

$F^2\Sigma \rightarrow X^2\Sigma(0,0)$ band at 2702 A: $B_v' = 5.78\ cm^{-1}$, $D_v' = 4.0 \times 10^{-4}\ cm^{-1}$; $B_v'' = 5.73\ cm^{-1}$, $D_v'' = 3.63 \times 10^{-4}\ cm^{-1}$; $\nu_0 = 36\,995.41\ cm^{-1}$.

MgD

$E^2\Sigma \rightarrow X^2\Sigma(0,0)$ band at 2816 A: $B_v' = 3.20\ cm^{-1}$, $B_v'' = 2.80\ cm^{-1}$; $\nu_0 = 35\,548.95\ cm^{-1}$.

11102 "FLOATING" HYDROGEN DENSITIES IN SOME MOLECULES OF THE TYPE XH_n. K.E.Banyard.
J. chem. Phys. (USA), Vol. 34, No. 6, 2105-8 (June, 1961).

The model of "floating" hydrogen densities was suggested initially by McDonald (Abstr. 8205 of 1960) in an analysis of the electron density for NH_4^+. The model, as used here, is an attempt to represent the molecular radial distribution as a superposition of the radial densities obtained from the "best" electronic wavefunctions (in the sense of the variation method) for the constituent atoms, the centres of the unperturbed hydrogen distributions being allowed to "float" inward along the bonds. The model is applied to H_2O and CH_4 and the molecular and bond dipole moments calculated. Thus for H_2O, which alone possesses a resultant moment, some insight could be obtained into the accuracy of the angular dependence of the density predicted by such a model. Comments are also made on NH_4^+ and NH_3. Further, the application of an approximate formula of Carter enables a determination to be made of the paramagnetic contribution to the molar diamagnetic susceptibility.

11103 REMARKS ON THE ELECTRONIC SPECTRA AND STRUCTURES OF COMPOUNDS OF CHROMIUM AND BENZENE. R.S.Berry.
J. chem. Phys. (USA), Vol. 35, No. 1, 29-35 (July, 1961).

An orbital level diagram and assignments of electronic spectra are given for the benzene-chromium compounds. These are based principally on symmetry arguments, atomic spectra and dichroism measurements. The problem of the energy involved in distorting benzene rings is also discussed.

11104 ELECTRONIC STRUCTURE, SPECTRA, AND MAGNETIC PROPERTIES OF OXYCATIONS. III. LIGATION EFFECTS ON THE INFRARED SPECTRUM OF THE URANYL ION. S.P.McGlynn, J.K.Smith and W.C.Neely.
J. chem. Phys. (USA), Vol. 35, No. 1, 105-16 (July, 1961).

For Pts I-II, see J. molecular Spectrosc.(USA), Vol. 6, 164, 188

(1961). A series of uranyl complexes $K_xUO_2L_y(NO_3)_2$, where L is the variable ligand (or ligands), was prepared; it is shown that a ligand series may be defined using the antisymmetric stretching frequency of the uranyl entity, and this series exhibits a remarkable parallelism with the spectrochemical series defined by Δ in octahedral complexes of transition metals of the 1st and 2nd series. This parallelism is rationalized using s mixed ligand field theory in which the uranyl ion is considered subject to bonding with ligands whcih are arranged hexagonally in a plane equatorial to the O—U—O axis. It is shown that the large changes of ν_3 and ν_1 are due primarily to electron population of the ϕ_u and δ_u atomic orbitals of uranium. Such population is physically equivalent to the reductions $AmO_2^{++} \rightarrow AmO_2^{+}$ and $NpO_2^{++} \rightarrow NpO_2^{+}$, which cause a decrease of approximately 100 cm^{-1} in ν_3. It is further shown that $\Delta\bar{\nu}_3$ = – electrostatic effect – $\sigma(L \rightarrow M) - \pi(L \rightarrow M) \pm \pi(M \rightarrow L)$, where in the last term the plus sign is the more probable, and the results obtained are rationalized using this equation. Some evidence in favour of linearity of the UO_2^{++} is also induced, and a general criterion for distinguishing the difficulty observable ν_1 re-established. It is also shown, although not discussed extensively, that the stability of uranyl complexes should increase, roughly as $\bar{\nu}_3$ (or $\bar{\nu}_1$) decreases:

THE INVERSION OF ZEEMAN SPLIT LEVELS.
See Abstr. 10587

THE SPEED OF INVERSION OF ZEEMAN SPLIT LEVELS.
See Abstr. 10588

TRANSFER MECHANISMS OF ELECTRONIC EXCITATION.
See Abstr. 11076

11105 THE VARIATION OF POTENTIAL OF THE LOW-LYING SINGLET AND TRIPLET STATES OF H_2 FOR LARGE INTER-NUCLEAR DISTANCES USING THE HEITLER–LONDON APPROXIMATION.
W.A.Bingel, H.Preuss and H.H.Schmidtke.
Z. Naturforsch. (Germany), Vol. 16a, No. 4, 434-5 (April, 1961).
In German.

Using a Heitler–London type wave-function the energies of the singlet (E_S) and triplet (E_T) states are calculated as a function of inter-nuclear distance, R. In general $E_T > E_S$ but the curves cross at R = 49.5 a.u. W.J.Orville-Thomas

11106 MAXIMUM-OVERLAP DIRECTED-HYBRID ORBITALS. T.L.Gilbert and P.G.Lykos.
J. chem. Phys. (USA), Vol. 34, No. 6, 2199-200 (June, 1961).

Outlines a simpler and more general procedure than that due to Murrell (Abstr. 5977 of 1960). J.Hawgood

11107 NOTE ON THE SEPARABILITY THEOREM FOR ELECTRON PAIRS. P.O.Löwdin.
J. chem. Phys. (USA), Vol. 35, No. 1, 78-81 (July, 1961).

It is shown that, if two functions $\Lambda_A(1, 2, 3, \ldots p)$ and $\Lambda_B(1', 2', 3', \ldots q')$ describing two groups A and B of electrons are orthogonal with respect to electron 1 then there exists a complete orthonormal set of one-electron functions $\phi_k(1)$ such that the functions actually occurring with nonvanishing coefficients in the expansion of one of the functions cannot simultaneously occur in the expansion of other function. This is a generalization of a separation theorem recently found by Arai (1960).

11108 ON THE APPROXIMATION OF ZERO DIFFERENTIAL OVERLAP. C.A.Coulson and L.J.Schaad.
J. chem. Phys. (USA), Vol. 35, No. 1, 294-7 (July, 1961).

The approximation of zero differential overlap is shown unreliable when applied to nonempirical calculations on HF and H_2.

11109 SCF LCAO STUDY OF LINEAR AND BENT ACETYLENE. L.Burnelle.
J. chem. Phys. (USA), Vol. 35, No. 1, 311-18 (July, 1961).

The self-consistent field molecular orbital method is applied to linear acetylene, and to the cis- and trans-bent molecule, for various values of the bending angle. All 14 electrons are taken into account,and free inner-shell outer-shell mixing is allowed. As for the multicentre integrals, they are evaluated by the Mulliken approximation. Reasonable values are obtained for the first ionization potential and for the excitation energy corresponding to the first $\pi \rightarrow \pi^*$ transition. The variation of the orbital energies induced by the distortion brings a confirmation of the qualitative predictions made by Walsh on the basis of the simple molecular orbital theory, but the treatment fails to predict the correct shape of the molecule in its first excited state, very likely because of the approximation of the three- and four-centre integrals. The difference in energy between the cis- and the trans-configurations is predicted correctl and there is a rough agreement between the calculated force constant and the experimental values. The results of an electron population analysis agree with experimental evidence and with the current views on hybridization, and they are confirmed by an examination o the equivalent orbital representation.

11110 STUDIES IN MOLECULAR STRUCTURE. IV. POTENTIAL CURVE FOR THE INTERACTION OF TWO HELIUM ATOMS IN SINGLE-CONFIGURATION LCAO MO SCF APPROXIMATION. B.J.Ransil.
J. chem. Phys. (USA), Vol. 34, No. 6, 2109-18 (June, 1961).

For Pt III, see Abstr. 6036 of 1961. Single-configuration LCAO MO SCF wave-functions and corresponding total energies are calculated for two ground-state He atoms interacting over an extensive range (0.4 to 12.0 A). Comparison with available experimental data is made; remarkably good agreement is obtained for distances greater than 1.5 A. For the first time, it is believed, an a priori account is given of both the van der Waals minimum an the repulsion region with a wave-function of sufficient flexibility to deal with both. The details of repulsion and of bonding in the van der Waals region are analysed in terms of atomic and overlap populations.

11111 THE IONIC CHARACTER OF CHEMICAL BONDS. E.Mooser and W.B.Pearson.
Nature (GB), Vol. 190, 406-8 (April 29, 1961).

An attempt is made to clear up the confusion which exists concerning the use of the term "ionic character of covalent bonds". W.J.Orville-Thoma

11112 RELATIVE BOND STRENGTHS IN TRIGONAL BIPYRAMID MOLECULES. F.A.Cotton.
J. chem. Phys. (USA), Vol. 35, No. 1, 228-31 (July, 1961).

Calculations of the relative strengths of the axial and equatori bonds in PF_5 and PCl_5 are made using Pauling's criterion of bond strength and using overlap integrals for Slater orbitals as suggeste by Mulliken. All calculations are for sp^3d hybridization through the entire range of distribution of s and d character between the axial and equatorial orbitals. The overlap integrals correctly predict that axial bonds are weaker than equatorial ones whereas Pauling's criterion predicts the opposite for all reasonable hybridi zation conditions.

11113 STUDY OF INTERMOLECULAR HYDROGEN BONDS. I. ALCOHOLS. II. CHLOROFORM. M.Martin.
Arch. Sci. (Switzerland), Vol. 13, No. Fasc. Spec., 519-26 (1960).
In French.

9th Colloque Ampère Paper (see Abstr. 4734 of 1961). The n.m.r. spectra of halogenated ethanols, alcohols containing double and triple C-C bonds, and higher homologues of methanol were studied: The solvents used were chloroform, tetrahydrofuran and triethylamine. The complexation of chloroform in various basic solvents is discussed. T.E.Peacoc

11114 THE VIBRATIONAL STRUCTURE OF ELECTRON EXCITATION LEVELS OF MOLECULES IN THE QUANTUM THEORY OF SCATTERING OF LIGHT.
L.L.Krushinskii and P.P.Shorygin.
Dokl. Akad. Nauk SSSR, Vol. 136, No. 3, 577-80 (Jan. 21, 1961).
In Russian.

For abstract, see Abstr. 9949 of 1961. [English translation in Soviet Physics—Doklady (USA), Vol. 6, No. 1, 54-6 (July, 1961)].

11115 E.S.R. STUDIES ON THE SEMI-CONDUCTOR THEORY OF FREE ELECTRONS IN LARGE ORGANIC MOLECULES. T.Allen and D.J.E.Ingram.
Arch. Sci. (Switzerland), Vol. 13, No. Fasc. Spec., 219-23 (1960).

9th Colloque Ampère Paper (see Abstr. 4734 of 1961). E.S.R. spectra of tyrosine, leucine, egg albumin and mixtures of amino acids and proteins irradiated at 3600 A at 90°K and 300°K were studied. In the first two cases there was no signal at 300°K. It appears that loosely bound water must be present for the energy level system of the protein to act as a semiconductor. T.E.Peacoc

11116 CALCULATION OF THE ELECTRON RESONANCE SPECTRUM OF THE CH RADICAL IN THE POLYCRYSTALLINE STATE. R.Lefevre.
Arch. Sci. (Switzerland), Vol. 13, No. Fasc. Spec., 234-5 (1960).
In French.

9th Colloque Ampère Paper (see Abstr. 4734 of 1961). The

hod of McConnell et al (J. Amer. Chem. Soc., Vol. 82, 766 60).) has been used to calculate the e.s.r. spectrum of the CH lical in the polycrystalline state. T.E.Peacock

11117 E.S.R. STUDIES ON THE BONDING IN COPPER COMPLEXES. D.Kivelson and R.Neiman.
chem. Phys. (USA), Vol. 35, No. 1, 149-55 (July, 1961).

ESR spectra of copper complexes are interpreted by means of olecular orbital theory, and the "covalent" characters of both σ d π bonds are discussed for a variety of compounds. Overlap egrals are considered in a consistent manner in treating σ bonds. rticular attention is given to Cu phthalocyanine and several of its rivatives. The in-plane π bonding may be as important in deter- ining the properties of a Cu complex as is the in-plane σ bonding.

11118 INTERMOLECULAR π EFFECT IN AROMATIC AND HETEROCYCLIC COMPOUNDS. Z.Pajak.
ch. Sci. (Switzerland), Vol. 13, No. Fasc. Spec., 527-33 (1960). French.

9th Colloque Ampère Paper (see Abstr. 4734 of 1961). Nuclear agnetic resonance was used to study two aspects of the problem the complexation of an acceptor with a π donor. The donors nsidered are benzene, naphthalene, pyrrole, thiophene, furan, clohexane, ether, tetrahydrofuran, diethylaniline and pyrrolidine solutions of chloroform, iodoform and bromoform, which act as ceptors. T.E.Peacock

11119 THE INFLUENCE OF LOCALIZED CHARGES ON THE MAGNETIC SHIELDING OF PROTONS IN ROMATIC CARBONIUM IONS. E.L.Mackor and C.MacLean.
rch. Sci. (Switzerland), Vol. 13, No. Fasc. Spec., 553-4 (1960). n French.

9th Colloque Ampère Paper (see Abstr. 4734 of 1961). In the bsence of a ring current and excess charges it would be expected hat the chemical shift of a substituted methyl group near to an lefinic carbon atom would be 228 c/s from benzene. In the enzene carbonium ion, the resonance peaks of the methyl group rotons are situated at 180, 187 and 198 c/s from benzene. From his it is inferred that the charges on the carbon atoms with espect to the CH_2 group are 0.25 (para), 0.16 (meta), and 0.21 ortho). T.E.Peacock

11120 SITE OF PROTONATION IN METHYL FORMATE. G.Fraenkel.
. chem. Phys. (USA), Vol. 34, No. 4, 1466-7 (April, 1961).

Argument based on n.m.r. proton spin coupling constants of nethyl formate and methyl formate dissolved in very strong acids ndicates that the ester protonates chiefly on the carbonyl oxygen. The same conclusion applies to the binding of BF_3 to methyl ormate. W.Good

11121 PROTON MAGNETIC RESONANCE SPECTRUM OF DIKETENE. D.W.Moore.
. chem. Phys. (USA), Vol. 34, No. 4, 1470 (April, 1961).

The high resolution spectrum of pure liquid diketene was bserved and is interpreted as confirmation of the proposed 3-buteno-β-lactone structure. E.F.W.Seymour

11122 DETERMINATION OF RELATIVE SIGNS OF SPIN COUPLING CONSTANTS IN AN AB_2X NUCLEAR MAGNETIC RESONANCE SPECTRUM. P.Diehl and I.Grünacher.
J. chem. Phys. (USA), Vol. 34, No. 5, 1846-7 (May, 1961).

AB_2X systems are the simplest systems allowing a determin- ation of the relative signs of the coupling constants J_{AB}, J_{AX}, and J_{BX}. An example is 1-fluoro-2,6-dichlorobenzene; the H^1 and F^{19} spectra can only be fitted if $J_{HF,para}$ has a sign opposite to that of $J_{HH,ortho}$ and $J_{HF,meta}$. E.F.W.Seymour

11123 N.M.R. SPECTRA OF SOME HALOGENATED PROPENES. J.D.Swalen and C.A.Reilly.
J. chem. Phys. (USA), Vol. 34, No. 6, 2122-9 (June, 1961).

The 40 Mc/s nuclear magnetic resonance spectra of $CF_3CF=CF_2$, cis and trans isomers of $CF_3CCl=CFCl$, and $CF_3CCl=CF_2$ are analysed in terms of the NMR parameters of the molecules; i.e., the magnetic shielding constants of the various fluorine nuclei and the spin–spin coupling constants between them. The spectrum of perfluoropropylene, $CF_3CF=CF_2$, is analysed adequately by a first-order perturbation treatment. The spectrum of each of the isomers of $CF_3CCl=CFCl$ is analysed exactly as and AB_3 system of spins by the use of the trace relations only. In a previous analysis of the cis-isomer, a small signal from the trans-isomer was not identified. This small signal is now proved to arise from the trans-isomer. The spectrum of $CF_3CCl=CF_2$ is analysed by an iterative scheme on an electronic computer. Here the nuclei are treated as an ABC_3 system of spins. The various magnetic parameters determined by these analyses are compared with the molecular structures and are briefly discussed in terms of the theories of the magnetic properties of molecules.

11124 N.M.R. SPECTRA OF VINYL CHLORIDE AND THE CHLOROETHYLENES.
E.B.Whipple, W.E.Stewart, G.S.Reddy and J.H.Goldstein.
J. chem. Phys. (USA), Vol. 34, No. 6, 2136-8 (June, 1961).

The NMR spectra of vinyl chloride, the three dichloroethylenes, and trichloroethylene were obtained and analysed. Three deuterated species of vinyl chloride were used to facilitate the analysis and to obtain all the C^{13}–H couplings in this molecule. The C^{13}–H couplings were also obtained for the other chloroethylenes. The NMR parameters are compared for the entire series of compounds, and it is shown that a definite parallelism exists between the chemical shifts and the C^{13}–H couplings. The results are discussed in terms of the inductive and mesomeric properties of the chlorine substituent.

11125 NUCLEAR QUADRUPOLE RESONANCE OF BrCl. M.A.Whitehead and H.H.Jaffé.
J. chem. Phys. (USA), Vol. 34, No. 6, 2204 (June, 1961).

A comparison of the bromine and chlorine resonance frequencies in the free atoms and in the BrCl molecules suggests that the bonding hybrid orbital has a few per cent d-orbital admixture. E.F.W.Seymour

11126 PROTON EXCHANGE IN CARBONIUM IONS OF METHYL-SUBSTITUTED BENZENES.
C.Maclean and E.L.Mackor.
J. chem. Phys. (USA), Vol. 34, No. 6, 2208-9 (June, 1961).

Nuclear magnetic resonance spectra observed at -75° C and 20° C for proton complexes of methyl-substituted benzenes demonstrated a type of proton exchange in which the exchanging proton shares its time between different positions within one ion, rather than between the ion and the acid solvent. E.F.W.Seymour

11127 NUCLEAR MAGNETIC RESONANCE SPECTRA OF F^{19} IN FLUORINATED AROMATIC COMPOUNDS.
V.F.Bystrov, É.Z.Utyanskaya and L.M.Yagupol'skii.
Optika i Spektrosk. (USSR), Vol. 10, No. 1, 138-41 (Jan., 1961). In Russian.

Chemical shifts in fluorinated aromatic ring compounds were measured with respect to the resonance line of fluorine in benzotrifluoride. The shift of fluorine in CF_3 groups decreased with increase of the electronegativity of a carbon atom to which a CF_3 group was attached. The shift was not greatly affected by introduction of various substituents into the benzene ring. [English translation in: Optics and Spectrosc. (USA), Vol. 10, No. 1, 68-70 (Jan., 1961)]. A.Tybulewicz

11128 SPECTRUM AND RADIUS OF OH^- IN SOLUTION. J.Jortner, B.Raz and G.Stein.
J. chem. Phys. (USA), Vol. 34, No. 4, 1455-6 (April, 1961).

The absorption spectrum of OH^-_{aq}, measured at several temperatures, leads to a value of 1.78 Å at 30° C for the mean ionic cavity radius. W.J.Orville-Thomas

11129 PROTON RESONANCE LINE SHAPE FOR A POLYCRYSTALLINE AROMATIC RADICAL. R.Lefebvre.
J. chem. Phys. (USA), Vol. 34, No. 6, 2035-8 (June, 1961).

A calculation is made of the resonance line shape for an in-plane proton of a polycrystalline aromatic radical in the case where the electron–proton hyperfine interaction is the only factor responsible for the resonance shift. Even with the inclusion of the anisotropic part of the electron–proton hyperfine interaction the position of the peak is linearly related to the unpaired π-electron density on the neighbouring carbon atom, ρ_C. The relation is very close to the one found for the solution. The line shape is very symmetrical with a width which increases for an increasing ρ_C. This behaviour is in good agreement with the recent results of Gutowsky and collaborators.

11130 TRAPPED RADICALS IN IRRADIATED n-PROPANOL AT 77° K. R.S.Alger, T.H.Anderson and L.A.Webb.
J. chem. Phys. (USA), Vol. 35, No. 1, 49-54 (July, 1961).

The free radicals formed in solid n-propanol by radiolysis were examined by electron paramagnetic resonance techniques and compared to radicals in photolyzed propanol–hydrogen peroxide mixtures. Identification of the radicals is based on modifications in the EPR h.f.s. introduced by substituting deuterium for hydrogen

at selected positions in the molecules. Radiolysis leads to radical formation by removing a hydrogen atom from the α carbon while photolysis apparently favours hydrogen abstraction from the β carbons. Mass spectrographic analysis of the gas liberated during irradiation have corroborative evidence regarding the hydrogen atoms; however, the analysis also showed that some hydrogen escaped from other than the α and β carbon positions. The experimental EPR h.f. spectra are compared with a series of constructed spectra obtained by summing Gaussian absorption curves according to the interactions indicated by the proposed models of the radicals.

11131 DISSOCIATION ENERGY OF CYANOGEN AND RELATED QUANTITIES BY X-RAY DENSITOMETRY OF SHOCK WAVES. H.T.Knight and J.P.Rink.
J. chem. Phys. (USA), Vol. 35, No. 1, 199-208 (July, 1961).

Density ratios across shock waves in a 0.85 Kr + 0.15 C_2N_2 mixture at an initial pressure of 50 mm Hg and room temperature, were determined with an X-ray densitometer as a function of shock velocity. The heat required to dissociate cyanogen into two CN radicals $D(C_2N_2)$ was determined to be 145 ± 6 kcal/mole by comparing the experimental data with curves of density ratio versus shock velocity calculated as a function of $D(C_2N_2)$. Dissociation energies of 174 ± 3 kcal/mole for CN and 129 ± 3 kcal/mole for HCN forming H and CN, and a heat of formation of 109 ± 3 kcal/mole for CN, were obtained by the application of Hess's law to the appropriate chemical reactions using this value of $D(C_2N_2)$ and the currently accepted values for the dissociation energy of nitrogen (225 kcal/mole) and the heat of sublimation of graphite (170 kcal/mole). The value of D(HCN) was confirmed by analogous density–velocity measurements on shock waves in a 0.85 Kr + + 0.15 HCN mixture. A rate constant for the recombination of CN to form C_2N_2 at 2900°K was deduced from the variation of density with time behind the shock. The value obtained was of the order of 1×10^9 (mole/litre)$^{-2}$ sec^{-1}.

11132 OPTICAL OBSERVATION OF THE DISSOCIATION OF MOLECULAR HYDROGEN IONS. R.H.Hughes.
J. Opt. Soc. Amer., Vol. 51, No. 6, 696-7 (June, 1961).

Describes results of observations of Doppler-shifted H lines after collisions of 200 and 130 keV H_2^+ and H_3^+ ions with H_2 or He, using the apparatus described in Abstr. 7435 of 1961. Electron exchange excitation of He triplet lines was also studied.

J.Hawgood

11133 NITROSYL CHLORIDE STRUCTURE. J.D.Rogers and D.Williams.
J. chem. Phys. (USA), Vol. 34, No. 6, 2195-6 (June, 1961).

Earlier measurements of rotational constants by means of microwave spectroscopy, by the same authors (Abstr. 6870 of 1951), are used to compute the N—O distance as 1.17 ± 0.06 A, the N—Cl distance as 1.95 ± 0.06 A, and the angle ONCl as 114° ± 3°. These values are in good agreement with electron diffraction results of Ketelaar and Palmer (1937). J.Sheridan

11134 DISTORTABLE DOUBLE WELL. A PROTOTYPE FOR THE ANALYSIS OF RELAXATION SPECTRA.
R.Fuchs and A.von Hippel.
J. chem. Phys. (USA), Vol. 34, No. 6, 2165-73 (June, 1961).

The origin of dielectric relaxation spectra is frequently not the rotation of dipoles as visualized in the Debye and Onsager models but the reversible transfer of ions or electrons between equilibrium sites. The displacement of such charge carriers corresponds to a reversal of dipole moments and had been treated previously as a shifting of charges between fixed equal or unequal double wells. The reversal of dipole moments in condensed phases, however, frequently has decisive after effects. The electrical unbalance created leads to a compensating action of the surroundings, lowering the free energy and tending to freeze in the charge in the occupied well site. Thus the double well becomes unequal because of the reaction of the embedding medium. This model of a distortable double well is here treated, first in its stationary state with and without superposed d.c. field and then in its a.c. response, under the simplifying assumption that the surroundings react by an exponen ially decaying distortion described by a time constant and final w depth. The characteristics of the model are that it incorporates t equal and unequal fixed double well as special cases but in additio shows an inherent distribution of relaxation times and — for long observation periods — an anomalously large polarizability, since eventually the wells can be turned with their deepened sites in the favourable field direction.

11135 ROLE OF EXCHANGE ENERGY IN INTERMEDIATE-RANGE INTERACTIONS. F.O.Ellison.
J. chem. Phys. (USA), Vol. 34, No. 6, 2100-4 (June, 1961).

Computations are made of the Coulomb and exchange parts o the interaction energies of a proton with a hydrogen atom and of two hydrogen atoms. It is found that the exchange energy become a more important and Coulomb energy becomes a less important fraction of the first-order interactions (i.e., interaction of ground state atoms with no configuration interaction) as the internuclear distance is increased. It is also shown that the first-order contri bution is necessary to bring the perturbation calculations of Coul on H_3^+ and of Löwdin and Hirschfelder on H_2 into good agreement with experiment for intermediate separations.

11136 ENERGY TRANSFER IN HYDROGEN-BONDED N-HETEROCYCLIC COMPLEXES AND THEIR POSSIBLE ROLE AS ENERGY SINKS.
M.Ashraf El-Bayoumi and M.Kasha.
J. chem. Phys. (USA), Vol. 34, No. 6, 2181-2 (June, 1961).

Describes studies of the quenching of fluorescent emission from carbazole by various concentrations of acridine, in hydrocarbon-glass solution. The quenching was greater for weak concentrations than complete H-bond association alone would predict, suggesting that an acridine-carbazole complex can trap energy from a collective excitation of free carbazole molecules.

J.Hawgo

11137 THE LENNARD-JONES 6-12 POTENTIAL PARAMETE OF H_2 AND D_2. H.F.P.Knaap and J.J.M.Beenakker.
Physica (Netherlands), Vol. 27, No. 6, 523-30 (June, 1961).

The difference in the Lennard-Jones potential parameters between H_2 and D_2 is calculated. This effect arises mainly from a difference in polarizability. The results are in good agreement with the experimental data of Michels et al. (Abstr. 6838 of 1960). Similar calculations were performed on the ortho and para modifi tions and here the calculated effect can account for the major part the difference in gaseous and liquid properties between the two species.

11138 RADIATION EFFECTS ON DIMETHYL-DIPHENYL SILOXANE COPOLYMER. I. PROTECTIVE EFFECT OF PHENYL RADICAL ON THE CROSS-LINKING.
M.Koike and A.Danno.
J. Phys. Soc. Japan, Vol. 15, No. 8, 1501-8 (Aug., 1960).

The radiation effects both of polydimethyl siloxane and dimethyldiphenyl siloxane copolymers were studied by the use of X-rays of Co^{60} in order to estimate the protective effect due to th phenyl radical against the radiation-induced cross-linking. The viscosity of the irradiated sample increased with the absorbed dose and finally the sample became a gel. The effeciency of cros linking of copolymers is remarkably reduced with increasing concentration of diphenyl siloxane. The minimum absorbed dose for gel formation and the efficiencies of cross-linking per monom unit were obtained as a function of the concentration of the phenyl radical. It is estimated that the protective effect of diphenyl siloxane may extend over five or six neighbouring monomers of dimethyl siloxane.

MOLECULAR ASSOCIATION IN SODIUM CYANIDE VAPOUR. See Abstr. 10551

INFLUENCE OF FLUCTUATIONS IN THE NUMBER OF MOLECULES ON THE FREQUENCY OF A MOLECULAR-BEAM MASER OSCILLATOR. See Abstr. 10791

SOLID-STATE PHYSICS

11139 ELECTROSTATIC BINDING ENERGY IN A BODY-CENTERED STRUCTURE OF PARALLEL CHARGE UBLET CHAINS. P.J.Jackson.
hem. Phys. (USA), Vol. 34, No. 6, 2119-21 (June, 1961).
The binding energy between chains in a body-centred tetragonal ucture, consisting of infinite charge doublet chains parallel to c axis, is considered as a function of two lattice parameters. aphs are plotted of the variation of the binding energy with these rameters. The results are applied to the particular case of taldehyde.

11140 DANGLING BONDS IN III-V COMPOUNDS. H.C.Gatos.
appl. Phys. (USA), Vol. 32, No. 7, 1232-4 (July, 1961).
The model proposed by Gatos and Lavine (Abstr. 11996 of 1960), discussed in the context of the available experimental facts and objection advanced by Holt (Abstr. 2366 of 1961). It is shown at the model as originally proposed is consistent with basic inciples and experimental observations.

11141 NATURE OF THE METALLIC ORBITAL. L.Pauling.
ature (GB), Vol. 189, 656 (Feb. 25, 1961).
An argument is presented to explain the fractional number .72) of metallic orbitals per atom, found when attempting to rrelate the author's theory of metals with experiment.
J.Hawgood

11142 THE SECOND LAW OF THERMODYNAMICS OF A SYSTEM WITH DIFFERENT LATTICE AND SPIN EMPERATURES. E.Fick.
hysica (Netherlands), Vol. 27, No. 4, 415-17 (April, 1961).
. German.
It is claimed that it is mathematically possible to set up an ppropriate generalization of thermodynamics. The author concludes at one cannot consistently "separate out" lattice and spin entropies the general case. No attempt is made to formulate the generalized second law" in terms of heat engines, but a more xtensive exposition is promised. H.N.V.Temperley

11143 ELECTRIC FIELD GRADIENTS IN POINT-ION AND UNIFORM-BACKGROUND LATTICES. F.W.de Wette.
Phys. Rev. (USA), Vol. 123, No. 1, 103-12 (July 1, 1961).
The lattice contribution to the field gradient in ionic crystals and metals is a quantity which has a well-defined value. However, for an actual evaluation, the field gradient is usually broken up into a number of conditionally convergent series with poor convergence. Rapidly convergent expressions for these series, and consequently, for the field gradient can be obtained by applying the method of plane-wise summation. This method is applied to the field gradient in ionic crystals with tetragonal and hexagonal symmetry and to the field gradient in tetragonal and hexagonal close-packed metal structures. As an example, an expression for the field gradient at the position of the anion is derived for ionic crystals with the CdI_2 structure. This expression is numerically evaluated for $CoBr_2$, $FeBr_2$, $MgBr_2$, $MnBr_2$, CaI_2, CdI_2, CoI_2, FeI_2, GeI_2, MgI_2, and MnI_2. Rather extensive numerical results are also presented for both close-packed metal structures, including values for the field gradient in Li, Be, Zn, In, and Rh.

11144 MAGNETIC SHIELDING OF A NUCLEUS BY FREE ELECTRONS. M.J.Stephen.
Phys. Rev. (USA), Vol. 123, No. 1, 126-30 (July 1, 1961).
The magnetic-shielding constant of a nucleus by free electrons is evaluated by obtaining the classical partition function for a system of free electrons in a uniform magnetic field perturbed by the field of a nuclear magnet. Both diamagnetic and paramagnetic terms are included in the Hamiltonian. For a highly degenerate gas, the shielding constant has oscillatory terms similar to those in the magnetic susceptibility of a free-electron gas. The possibility of observing these terms is discussed.

NUCLEAR ORIENTATION OF Dy^{155} AND Dy^{157}.
See Abstr. 10958

LATTICE MECHANICS

11145 LATTICE DYNAMICS OF ALPHA URANIUM. D.O.van Ostenburg.
Phys. Rev. (USA), Vol. 123, No. 4, 1157-62 (Aug. 15, 1961).
The method developed by Begbie and Born (Abstr. 1354-5 of 1947) was applied to alpha-uranium, where equations are developed which give the macroscopic elastic constants in terms of the microscopic force constants. Interactions of an atom with its first through fourth nearest neighbours, which involve twelve atoms, are considered. Through symmetry considerations, nineteen atomic force constants enter into this force system. An independent determination of the force constants is required before a valid verification of the solutions can be made. However, using measured values of the nine elastic constants, two sets of force constants are evaluated, one based upon quasi-central forces and the other upon neglect of fourth nearest neighbours.

11146 DEBYE–WALLER FACTOR IN MÖSSBAUER INTERFERENCE EXPERIMENTS. H.J.Lipkin.
Phys. Rev. (USA), Vol. 123, No. 1, 62-3 (July 1, 1961).
A simple calculation is presented of the effects of lattice dynamics on interference between Mössbauer processes and corresponding atomic processes, i.e., between Mössbauer and Rayleigh scattering, or between internal conversion of Mössbauer radiation and the photoelectric effect. When the energy of the emitted γ-ray or electron is not measured, it is necessary to sum over all possible final states of the lattice. The interference contribution is found to be attenuated by the same "Debye–Waller" factor as the ordinary Mössbauer contribution, depending only upon the momentum of the incident γ-ray. If the energy of the emitted γ-ray is measured (e.g., by a Bragg scattering experiment), the atomic contribution is attenuated by the usual X-ray Debye–Waller factor, depending upon the momentum transfer, the Mössbauer contribution by the square of the usual Mössbauer factor, and the interference term by the geometric mean of the atomic and Mössbauer factors.

11147 RECOIL-FREE RESONANT ABSORPTION IN Au^{197}. D.A.Shirley, M.Kaplan and P.Axel.
Phys. Rev. (USA), Vol. 123, No. 3, 816-30 (Aug. 1, 1961).
Presents the results of a series of experiments which exploit the sensitivity of the Mössbauer effect to energy changes produced by the environment of atomic nuclei. The Mössbauer absorption in Au was measured at 4°K for the 77 keV gamma-ray emitted by Au^{197} nuclei embedded in gold, platinum, stainless steel, iron, cobalt, and nickel. In each case, a Doppler-shift curve was measured to find the effective width and the chemical shift. The recoil-free fractions, f, are obtained with the aid of a straightforward analysis, which incidentally shows the errors that can be made in f if the chemical shift and effective width are not taken into account. The observed recoil-free emission fractions were found to be approximately 0.06 (Au), 0.34 and 0.14 (Pt), 0.24 (steel), 0.32 (Fe), 0.27 (Co), and 0.35 (Ni). The relative f values are correct; the correct absolute f values might require a multiplicative correction factor that could be as small as 0.53. Relatively large f values were obtained when the Au^{197} radioactive nuclei were in high Debye-temperature lattices composed of light nuclei. Particularly low f values were found when the largest radiation-damage effects were expected. The observed chemical shifts were (in units of 10^{-6} eV): < 0.13 (Au), 0.26 (Pt), 1.3 (steel), 1.4 (Fe), 1.3 (Co), and 1.1 (Ni). These chemical shifts give information more directly interpretable than, but related to, the optical-isotope and isomer shifts and the Knight shift; the magnitudes of the shifts measure directly either the depletion or the enhancement of electron density at the radioactive nuclei in the different lattices. Zeeman splittings of the nuclear energy levels caused by local magnetic fields at Au has relative magnitudes of 1.0 : 0.43: < 0.10 for Fe, Co, and Ni lattices. If the magnetic moment of the 77 keV excited state in Au^{197} is 1.6 n.m., the local magnetic fields in Fe and Co were 282 and 122 kOe, respectively.

11148 A THEORY OF VIBRATIONS OF FINITE CRYSTAL LATTICES. O.P.Girin.
Optika i Spektrosk. (USSSR), Vol. 9, No. 5, 673-6 (Nov., 1960). In Russian.

Describes a method of calculating the exact frequencies and amplitudes of bond vibrations in systems possessing translational symmetry and a small number (one or several) of unit cells. The method is based on the technique developed by Vol'kenshtein, El'yashevich and Stepanov (1949) for vibrational spectra of molecules; crystals are regarded as gigantic molecules. [English translation in: Optics and Spectrosc. (USA), Vol. 9, No. 5, 355-6 (Nov., 1960)]. A.Tybulewicz

11149 LATTICE VIBRATION AND RANDOM WALK PROBLEMS. E.Teramoto.
Progr. theor. Phys. (Japan), Vol. 24, No. 6, 1296-1306 (Dec., 1960).

Mathematical relations between the lattice vibration and the random walk problems are presented for the case of a system of one-dimensional harmonically coupled oscillators. It is shown that the Laplace and Mellin transforms of the frequency spectrum of the lattice vibration can be expressed in terms of the transition probabilities of the random walk problems with the continuous and discrete time parameters respectively.

11150 TIME DEPENDENT PROBLEMS OF THE LOCALIZED LATTICE VIBRATION. E.Teramoto and S.Takeno.
Progr. theor. Phys. (Japan), Vol. 24, No. 6, 1349-68 (Dec., 1960).

The time-dependent problems of the vibrational motion are investigated for the cases of an infinitely extended one-dimensional lattice which contains one or two impurity atoms (isotopes). Starting from the equations of motion of these systems, the authors derive the integral equations which show various time-dependent properties of the lattice vibration of these perturbed one-dimensional lattices. The asymptotic solutions of these integral equations represent the localized vibration which is preserved by the impurity atom when its mass is smaller than that of the base atoms. The integral equations are solved by means of a perturbation calculation and also by the use of Laplace transforms, and the behaviour of the lattice vibration, especially the capture of the vibrational energy by the impurity atoms, are examined.

11151 LATTICE FREQUENCY OF IONIC CRYSTALS. S.S.Mitra and S.K.Joshi.
J. Phys. Soc. Japan, Vol. 15, No. 9, 1575-6 (Sept., 1960).

Using an inverse power type repulsive potential, two different expressions for the frequency are obtained, one in terms of the cohesive energy and the other in terms of the compressibility of the crystal.

11152 A THEORY OF THE EFFECT OF DAMPING IN IONIC CRYSTALS. V.V.Mitskevich.
Izv. vysshikh uchebnykh zavedenii, Fizika (USSR), 1960, No. 4, 6-12. In Russian.

Density matrices are employed to deal with interaction of light with ionic crystals, allowing for anharmonicity of the lattice vibrations which is responsible for damping. The temperature dependence of the parameters of an absorption line is studied. At high temperatures the "wings" of the line increase with temperature and the absorption maximum rises with increase of temperature.
A.Tybulewicz

11153 FREQUENCY SPECTRUM OF A DISORDERED ONE-DIMENSIONAL LATTICE. J.S.Langer.
J. math. Phys. (USA), Vol. 2, No. 4, 584-91 (July-Aug., 1961).

The frequency spectrum of a disordered one-dimensional lattice is calculated via an investigation of the phonon propagator. The spectrum is evaluated in detail for a low concentration of light impurities inserted at random along a linear chain. It is found that an impurity band occurs near the frequency of the local mode. Higher-order effects resulting from clusters of impurities are calculated and discussed.

11154 ENERGY SPECTRUM OF LATTICES WITH DEFECTS. I. GENERAL THEORY. S.Takeno.
Progr. theor. Phys. (Japan), Vol. 25, No. 1, 102-20 (Jan., 1961).

An attempt is made to calculate the spectrum of the vibrational frequencies as well as that of electronic energy levels of crystal lattices with defects. It is shown that the Fourier or the Laplace transform of the spectrum can be obtained from the trace of density matrices which satisfy a set of simultaneous differential-difference equations. Formal solutions of these equations are given, which are analogous to the integral expressions for additive functions of normal mode frequencies originally used by Montroll and Potts (Abstr. 792, 4078 of 1956). As another approach to the solution of the equations, the perturbation expansion method is employed, which yields a cluster expansion or an expansion in terms of the concentration of defects. Finally the moment method and its correspondence to the random walk problem are discussed.

11155 INTERMOLECULAR COUPLING OF VIBRATIONS IN MOLECULAR CRYSTALS. II. INTERMOLECULAR FORCES IN CH_3Cl AND CD_3Cl. D.A.Dows.
J. chem. Phys. (USA), Vol. 35, No. 1, 282-7 (July, 1961).

The effect of isotope substitution on band splittings caused by dipole coupling between molecules is examined. For methyl chloride and methyl bromide, the results support the contention that the theory of dipole coupling in its present form is not sufficien to explain the splittings in most bands. The theory of atom–atom interactions presented in Pt I (Abstr. 11566 of 1960) of this series is applied to various possible potentials coupling the motions of normal and deuterated methyl chloride molecules. A repulsive potential acting between hydrogen atoms of neighbouring molecules accounts for the splittings of several bands. Certain types of coupling potentials seem ruled out by the results of these calculations, while others are left as possible factors in band shifts which occur when a gas is condensed.

11156 SOME NEW INTERRELATIONS IN THE PROPERTIES OF SOLIDS BASED ON ANHARMONIC COHESIVE FORCES. J.N.Plendl.
Phys. Rev. (USA), Vol. 123, No. 4, 1172-80 (Aug. 15, 1961).

The lattice vibration spectrum of a solid can be characterized by one single frequency, which is defined as "the frequency of the centre of gravity" of this spectrum or simply "centre frequency" From its equality with the characteristic frequency of specific heat the "centre law of the lattice vibration spectra" was recently derived. In assuming now that in a lattice, at equilibrium, the hypothetical maximum of vibrational energy (kinetic energy) of an atom (ion) pair equals the total cohesive energy (potential energy), and at the same time considering the anharmonicity of lattice vibrations, a basic inter-relation between centre frequency and tota cohesive energy is derived. It constitutes a substantial extension of the above "centre law". Its validity is illustrated for 26 solid compounds of six different lattice structures which cover almost the entire range of lattice vibration spectra of solids. This interre lation allows a first determination of thus far inaccessible data on cohesive energy for solids of extremely high sublimation temperatures, such as silicon carbide, boron nitride, and the two types of diamond. Detailed study of the anharmonicity of lattice vibrations results in additional interrelations, such as one between exponent of repulsion and "related mass" [= reduced mass of the vibrating atom (ion) pairs related to argon], one between exponent of repulsio and "relative compressibility" (change of compressibility with pressure over compressibility), and one between "relative compressibility" and "related mass". In combining the two interrelations of centre frequency, with characteristic temperature and with cohesive energy, the author derives an interrelation between characteristic temperature and total cohesive energy. Examination of the relationship between anharmonicity and atomic behaviour and suggests a classification of solids according to their different anharmonic force characteristics. The solids can have either a soft or linear or hard force characteristic, dependent on the configuration which they resemble in the periodic chart of the atoms. The underlying concept of anharmonicity deduced in this paper help to understand the physical properties of solids from an atomistic point of view.

LATTICE ANHARMONICITY AND OPTICAL ABSORPTION IN POLAR CRYSTALS. See Abstr. 11360

IMPURITY INDUCED INFRARED LATTICE VIBRATION ABSORPTION. See Abstr. 11378

11157 PHOTOSENSITIVE-ULTRASONIC PROPERTIES OF CADMIUM SULFIDE. H.D.Nine and R.Truell.
Phys. Rev. (USA), Vol. 123, No. 3, 799-803 (Aug. 1, 1961).

Ultrasonic attenuation in single crystals of CdS was observed to be a function of light irradiation. Two distinct types of behaviou were observed. Some crystals (type A) show a decrease of attenuat with white light application, and others (type B) show an increase o attenuation with white light. The ultrasonic attenuation and the conductance of the crystals were measured as a function of temper ture. An excellent correlation between the conductance and the ultrasonic attenuation is evident for type B crystals. A strong

rrelation between the directional piezoelectric properties of CdS d the ultrasonic attenuation in both types of CdS is also shown. interaction between conduction electrons and stress waves coupled the piezoelectric property of CdS is isolated as the dominant chanism for the photosensitive ultrasonic attenuation in CdS of pe B. Two or more competing effects appear to be responsible r the type A photosensitive attenuation behaviour.

ELECTROMAGNETIC WAVE PROPAGATION IN MOLECULAR RYSTALS WITH WEAK EXCITON–PHONON INTERACTION. e Abstr. 11347

PHONON MASERS AND THE PHONON BOTTLENECK. e Abstr. 11475

11158 LOW QUANTUM TRANSITIONS IN WATER AND ICE. H.R.Danner and H.H.Stiller.
ysica (Netherlands), Vol. 27, No. 4, 373-5 (April, 1961).

Experiments are described in some detail in which neutrons e scattered by ice. By plotting the number of scattered neutrons gainst their energy it is found that there is an incoherent component. corresponds to a process in which an energy of 4.7×10^{-4} eV is ansmitted to the neutrons. The nature of this process is not ientified but it is known that processes of comparable energy show the neutrons scattered by liquid water. R.Eisenschitz

Thermal Properties

11159 ATOMIC FORCES AND THERMAL EFFECTS IN SOLIDS. H.B.Rosenstock.
. chem. Phys. (USA), Vol. 35, No. 2, 420-3 (Aug., 1961).

It is shown that the vanishing of an interatomic force constant n a solid can produce specific heat anomalies very similar to the amiliar "lambda point" phenomena. Possible application of this to igher order phase transitions is discussed.

11160 HEAT CAPACITIES OF $DyCo_3$ IN RELATIONSHIP TO ITS MAGNETIC ANOMALY, THIRD LAW ENTROPIES AND RELATED THERMOCHEMICAL DATA.
V.G.Saba and W.E.Wallace.
. chem. Phys. (USA), Vol. 35, No. 2, 689-92 (Aug., 1961).

Heat capacities of $DyCo_3$ are reported for the temperature ange extending from 12° to 470°K. Evaluation of the third law ntropies of the compound gives [in cal deg^{-1} (g formula weight)$^{-1}$] 55.61 ± 0.05 and 72.05 ± 0.07 at 298.16° and 450°K, respectively. Excess heat capacity is observed between 275° and 400°K, seemingly due to the previously observed magnetic anomaly at 360°K. Analysis of the data suggests that there is an appreciable magnetic contribution to the heat capacity throughout the temperature range covered. The profile of the thermal anomaly at about 350°K is unusual suggesting that the alteration of magnetic structure which produces it is also unusual.

11161 SPECIFIC HEATS OF DILUTE Cu–Co ALLOYS BETWEEN 1.5° and 4.5°K.
L.T.Crane and J.E.Zimmerman.
Phys. Rev. (USA), Vol. 123, No. 1, 113-16 (July 1, 1961).

Specific heats of eight specimens of dilute copper–cobalt alloys were measured in the range of 1.5° to 4.5°K. Cobalt concentration of these samples lay between ¼ and 2½ wt.%. At all concentrations the specific heat is greater than that of pure copper, with the excess linear in temperature and quadratic in concentration for the lower concentrations at the higher temperatures. Near the lower end of this temperature range, samples of greater than ½% cobalt also exhibit an additional anomaly which appears to have a characteristic temperature proportional to cobalt concentration. A comparison to the specific heats of dilute Cu–Mn alloys shows that the magnetic interactions in Cu–Co and Cu–Mn must differ greatly in character.

11162 LOW-TEMPERATURE SPECIFIC HEAT OF INDIUM AND TIN. C.A.Bryant and P.H.Keesom.
Phys. Rev. (USA), Vol. 123, No. 2, 491-9 (July 15, 1961).

The heat capacities of indium and tin were measured between 0.4 and 4.2°K. In the normal state, the specific heat could be represented by $AT^{-2} + \gamma T + \alpha T^3 + \beta T^5 + \mu T^7$. For Sn, in molar millijoule units, A = 0; γ, the coefficient in the electronic terms, is 1.80; α = 0.242, corresponding to a Debye temperature, θ_0, of 200°K; β = 0.004; and μ = 0.00014. For In, A, the coefficient of a nuclear electric quadrupole term, is calculated to be 8.97×10^{-4} from resonance data; γ = 1.61 for one ingot and 1.59 for another; θ_0 = 109° and 108°K; and β = 0.008. In the superconducting state, the specific heat of Sn could be expressed as the normal lattice term plus an electronic term of the form $a\gamma T_c \exp(-bT_c/T)$, with T_c = 3.70°K (0.02 deg lower than found in a magnetic measurement), a = 7.63, and b = 1.41 when $2 < T_c/T < 7$; the value of b agrees with infrared measurements of the energy gap. This sort of analysis could not be applied to In, for below 3.8°K the total superconducting specific heat was less than the normal lattice term. A possible interpretation is that θ_0 is 9% higher in the superconducting state than in the normal metal at 0.4°K; this is not supported, however, by the recent acoustic measurements of the elastic constants by Chandrasekhar and Rayne. The anomaly is not as yet understood, but a few plausible explanations are discussed.

SPIN-WAVE CONTRIBUTION TO THE SPECIFIC HEAT OF IRON. See Abstr. 10203

11163 HEAT CAPACITY OF THULIUM FROM 15° TO 360°K. L.D.Jennings, E.Hill and F.H.Spedding.
J. chem. Phys. (USA), Vol. 34, No. 6, 2082-9 (June, 1961).

Thulium shows a lambda anomaly in its heat capacity near 55°K which is associated with magnetic ordering and which shows thermal hysteresis. In addition, there are anomalous changes in the slope of the heat capacity curve near 88°, 162°, and 180°K. These changes and the unexpectedly low value of the slope near room temperature complicate the analysis of the data, but there is evidence that the effective exchange integral in thulium is appreciably larger than that for neighbouring rare earths. The results in the temperature range from 14° to 21°K support a T^3 dependence of the magnetic specific heat as predicted by spin wave theory for an antiferromagnet. The thermodynamic functions are tabulated for the temperature range studied.

11164 SPECIFIC HEATS OF DELTA-PHASE Zr–H AND Zr–D. W.J.Tomasch.
Phys. Rev. (USA), Vol. 123, No. 2, 510-14 (July 15, 1961).

The specific heats of f.c.c. $ZrH_{1.58}$ and $ZrD_{1.58}$ were measured in the temperature interval 30-500°C. The data are interpreted in terms of a harmonic oscillator model for the hydrogen and deuterium specific heat contributions. This model is in accord with recent inelastic neutron scattering studies and predicts an isotopic depression of the deuteride Einstein temperature by a factor of $1/\sqrt{2}$ relative to the hydride value. Over the interval 30-200°C, the data and model are quantitatively consistent. At higher temperatures, the deuteride specific heat is somewhat smaller than anticipated. Quantities of non-cubic γ-phase material are known to be present in the samples used, particularly in the deuteride, and this is though to be a likely cause for the deviations. The hydride Einstein temperature calculated from the difference between deuteride and hydride specific heats at 150°C is 1500 ± 300°K, as compared with the inelastic neutron scattering value of 1500 ± 60°K.

ANOMALOUS LATTICE SPECIFIC HEAT OF SUPERCONDUCTORS. See Abstr. 10645

11165 EFFECTIVE X-RAY AND CALORIMETRIC DEBYE TEMPERATURE FOR COPPER.
P.A.Flinn, G.M.McManus and J.A.Rayne.
Phys. Rev. (USA), Vol. 123, No. 3, 809-12 (Aug. 1, 1961).

The Debye–Waller factor for copper was determined from X-ray intensity measurements on a single crystal over the temperature range 4.2°-500°K. From a machine calculation of the vibrational spectrum of copper the values of the specific heat and Debye–Waller factor were obtained and compared with those found by experiment. The agreement indicates that for copper the central force model with nearest- and second-neighbour interactions is adequate for the interpretation of effects depending on simple averages over the frequency spectrum.

11166 TEMPERATURE-COMPENSATED DEBYE TEMPERATURE OF CARBONYL IRON.
C.P.Gazzara and R.M.Middleton.
J. appl. Phys. (USA), Vol. 32, No. 8, 1546-8 (Aug., 1961).

The explicit temperature function τ which relates the Debye temperature to a change in temperature was found to be 4.1 for annealed carbonyl iron from X-ray diffraction integrated intensity measurements. The corresponding Debye temperature, corrected for temperature diffuse scattering, was calculated to be 435°K at temperature 310°K.

11167 SHOCK WAVE COMPRESSION OF HARDENED AND ANNEALED 2024 ALUMINUM. G.R.Fowles.
J. appl. Phys. (USA), Vol. 32, No. 8, 1475-87 (Aug., 1961).

Measurements of the Hugoniot equations of state of hardened

and a[illegible]ealed 2024 aluminium at pressures below 50 kbar are presented. The major aim of the experiments was to determine the validity of elastic-plastic theory, which predicts that, at a given compression, the stress normal to the shock front is larger than the hydrostatic pressure necessary to produce the same compression by an amount equal to two-thirds the yield strength in simple tension. Oblique shock geometry was employed. Shock and free-surface velocities were recorded with a streak camera by means of a light-reflection technique employing the principle of the optical level. This technique provides continuous recording of free-surface motion with time, an essential requirement because of the existence of a double shock system. The observed elastic wave amplitudes (5.4 ± 0.2 kbar and 0.9 ± 0.2 kbar for hardened and annealed material, respectively) agree within experimental precision with values predicted from static tensile specimen data. The shock wave data, in the range 25-50 kbar, yield one-dimensional strain isotherms which, while significantly different for the two different hardness conditions, agree within experimental precision with semitheoretical curves based on Bridgman's hydrostatic data to 30 kbar and on simple tension stress-strain data. No significant strain rate effects are evident. It is concluded that elastic-plastic theory is valid for the description of plane shock waves in this material.

11168 PRELIMINARY MEASUREMENTS TO DETERMINE THE THE EFFECT OF COMPOSITION ON THE THERMAL CONDUCTIVITY OF GLASS. E.H.Ratcliffe.
Phys. Chem.Glasses (GB), Vol. 1, No. 3, 103-4 (June, 1960).

Results of steady-state thermal conductivity measurements on a group of commercial and experimental glass samples, each in the form of a pair of 3 in. diameter disks of 3/8 in. thickness, are given. The thermal conductivity at 20°C and the % increase in conductivity between 10° and 30°C are listed, and the conductivity as a function of temperature for the temperature range −150° to 100°C is shown graphically. S.Weintroub

11169 CONNECTION BETWEEN THERMAL AND OPTICAL PROPERTIES OF In_2Te_3.
V.A.Petrusevich, V.M.Sergeeva and I.A.Smirnov.
Fiz. tverdogo Tela (USSR), Vol. 2, No. 11, 2894-8 (Nov., 1960).
In Russian.

Measurements of the lattice thermal conductivity of coarse-grained samples between 200° and 400°K indicated the presence of additional thermal conductivity which could be accounted for by heat transfer via electromagnetic radiation. [English translation in: Soviet Physics—Solid State (USA)]. A.Tybulewicz

11170 ON THE INFLUENCE OF THALLIUM ON THE THERMAL CONDUCTIVITY OF POLYCRYSTALLINE SELENIUM. G.B.Abdullaev, M.I.Aliev and S.A.Akhundova.
Fiz. tverdogo Tela (USSR), Vol. 3, No. 2, 326-7 (Feb., 1961).
In Russian.

For abstract, see Abstr. 9989 of 1961. [English translation in: Soviet Physics—Solid State (USA), Vol. 3, No. 2, 234-5 (1961)].

11171 ON THE CHANGE IN THE THERMAL CONDUCTIVITY OF TIN, BISMUTH AND GALLIUM ON MELTING.
B.P.Pashaev.
Fiz. tverdogo Tela (USSR), Vol. 3, No. 2, 416-19 (Feb., 1961).
In Russian.

For abstract, see Abstr. 9990 of 1961. [English translation in: Soviet Physics—Solid State (USA), Vol. 3, No. 2, 303-5 (Aug., 1961)].

11172 THERMAL SHOCK BEHAVIOUR OF BRITTLE MATERIALS. M.L.Levin.
Nature (GB), Vol. 190, 521-2 (May 6, 1961).

The materials investigated were silica, soda glass, borosilicate glass and electrical porcelain. An argon plasma jet was allowed to strike the surface for 0.16 sec every 2 sec for up to 1000 times. At high heat loadings a fine series of shallow surface cracks was formed immediately. At low heat loadings cracks through the body of the specimen appeared some time after the shock treatment. D.M.Schlapp

ELECTRON STATES

11173 ELECTRON WAVE FUNCTIONS IN METALLIC SODIUM. J.Callaway.
Phys. Rev. (USA), Vol. 123, No. 4, 1255-6 (Aug. 15, 1961).

Wave-functions to order k^3 are presented for electrons in metallic sodium. The calculation is an application of the cellular method. The empirical potential of Prokofjew was employed. See also Abstr. 5126, 5144 of 1959; 13517 of 1960.

11174 THE VARIATIONAL METHOD FOR [THE CALCULATI OF] THE TRANSPORT PARAMETERS OF ELECTRON CONDUCTORS. R.Klein.
Z. Naturforsch. (Germany), Vol. 16a, No. 1, 116-21 (Jan., 1961).
In German.

The variational functions are developed as a series of polynomials of the reduced energy; these polynomials form a complete orthogonal system. The calculation of transport properties is simplified by this method. E.P.Wohlfar

11175 GENERALIZED KOOPMANS' THEOREM. J.C.Phillips.
Phys. Rev. (USA), Vol. 123, No. 2, 420-4 (July 15, 1961).

Koopmans' theorem states that if the wave-function of a many electron system is approximated by a Slater determinant of Hartree—Fock one-electron wave-functions, with one-electron en gies defined as the difference in energy of (N + 1)- and N-particle systems, then these one-electron energies are given by the expec tion value of the Hartree—Fock Hamiltonian with respect to the or electron wave-functions. Koopmans' theorem is here generalized include correlation effects by using Hubbard's expression for the total energy of a free-electron gas. The resulting one-electron Hamiltonian contains in first-order screened exchange. Hubbard' lowest polarization diagram gives, in addition, part of the screene second-order Coulomb interactions, which is small for metallic densities. Collective terms are also obtained. Comparison with Bohm—Pines Hamiltonian shows a one-to-one correspondence, bu with different cutoff functions in each term. Following Hubbard, t method is extended to include the effects of a peridoic potential to first order. The resulting one-electron Hamiltonian provides a c venient and accurate basis for self-consistent energy band calcul tions including exchange and correlation in metals and semiconductors.

11176 THE BAND STRUCTURE OF AMORPHOUS SOLIDS. P.Phariseau.
Physica (Netherlands), Vol. 27, No. 3, 351-2 (March, 1961).

A linear amorphous solid is represented as being locally a perturbed Kronig—Penney crystal, and an equation for the first-order disturbance of the bands is obtained. See Abstr. 9153 of 1961. J.Hawgo

11177 ELECTRON ENERGY LEVELS IN CRYSTALS. II. SERIES OF HOMOLOGOUS ACTIVATORS. M.Balarin.
Ann. Phys. (Germany), Vol. 7, No. 3-4, 113-22 (1961). In German

The central ion model of Pt I for Tl^+ centres (see Abstr. 362 of 1961) is used to obtain more generalized results applicable to similar activators, e.g. ions with isoelectronic configurations. G.F.J.Garli

TUNNELLING FROM AN INDEPENDENT-PARTICLE POINT OF VIEW. See Abstr. 10639

11178 ON THE ENERGY BANDS OF THE CHAIN LATTICE OF THE SELENIUM TYPE. E.Behrens.
Z. Phys. (Germany), Vol. 163, No. 2, 140-3 (1961). In German.

The selenium lattice may be considered as intermediate between the two extreme cases of a chain in which each atom is bonded to two opposite neighbours, and the simple cubic lattice. T band structure of the second limiting case is here investigated by simple tight binding procedure. Along the direction of the chain th bands are found to behave qualitatively as in the other extreme approximation, so that interpolation is straightforward. L.Pincherl

11179 COLLECTIVE EXCITATION OF ELECTRONS IN DEGENERATE BANDS. II. COLLECTIVE EXCITATIO IN A METALLIC p-BAND. T.Izuyama.
Progr. theor. Phys. (Japan), Vol. 24, No. 4, 899-907 (Oct., 1960).

For Pt I, see Abstr. 3883 of 1961. Various collective oscilla-

ıs of electrons are examined in an idealized metallic p-band del. It is concluded that oscillations other than the density illation are unstable unless rather inconceivable conditions satisfied.

11180 THE FERMI SURFACE.
Edited by W.A.Harrison and M.B.Webb.
w York, London: John Wiley (1960) 356 pp.

Proceedings of an international conference held at Cooperstown, w York on August 22-24, 1960. The conference was sponsored by Air Force Office of Scientific Research (U.S.A.) and the General ectric Research Laboratory (New York). The proceedings are ided into 8 sections, each corresponding to one session and lowed by a report of the discussion. The sections are:

I. Theory;
II. De Haas–van Alphen effect;
III. Galvanomagnetic effects;
IV. Cyclotron resonance;
V. Anomalous skin effect;
VI. Magnetoacoustic effect;
VII. Transport properties and studies of alloys;
VIII. Summary.

he proceedings have author and subject indexes. For abstracts the individual papers see this and subsequent issues of Physics bstracts.

11181 POLARON MOTION IN A STRONG ELECTRIC FIELD.
Yu.I.Horkun.
krayin. fiz. Zh. Dodatok (USSR), Vol. 3, No. 2, 32-9 (1958).
Ukrainian.

Not only the dependence of the polaron ψ-function on the drift elocity, but also the potential well deformation due to the ccelerating electric field is taken into account. The appropriate olution of Schrödinger's equation is given. The $\psi_0(\lambda)$ function escribing the fluctuational motion of the electron is found by the irect variational method. The approximation parameters $= 2av/\omega$ and β are given as functions of the dimensionless velocity $= v/\omega r_0$. Also given are the values of the strength of the electric eld in which the polaron moves evenly with velocity u. According o Hippel's criterion the maximum strength of such a field should e identified with the breakdown strength. A formula derived for he breakdown strength gives values about 25% lower than Horkun's alues (1956-7) but 2-3 times higher than experimental ones. A ependence of the electron potential energy on $x = 2a\lambda_x$ is found t external field strength $E = E_{max}$, this case representing the reatest "danger" for polaron existence. It is shown that the depth f the potential well is sufficient for the existence of a discrete lectron level.

11182 ON THE THEORY OF WEAK EXCITATION OF THE ELECTRON SYSTEM IN A SOLID BODY. G.G.Taluts.
Fiz. Metallov i Metallovedenie (USSR), Vol. 6, No. 6, 1130-2 (1958). In Russian.

The method of collective coordinates in the framework of second quantization is used to derive an expression for the energy of collective oscillation of the electrons. This expression reduces to the usual ones for the excitation energy of excitons and plasmons. [English translation in: Phys. Metals and Metallography (GB), Vol. 6, No. 6, 172-4 (1958)]. K.G.Major

11183 THE COLLECTIVE TREATMENT OF A FERMI GAS. II.
T.Gaskell.
Proc. Phys. Soc. (GB), Vol. 77, Pt 6, 1182-92 (June, 1961).

For Pt I see Abstr. 1085 of 1959. The ground-state energy of the free electron gas is calculated using the Rayleigh–Schrödinger variational method with the wave-function $\Psi = D\prod_i < j f(x_{ij})$ where D is a determinant of plane waves and $f(x_{ij})$ a correlation function. Consideration of the wave-function in terms of the collective coordinates ρ_k, the Fourier components of the density, suggests an accurate approximation for the energy integral which is then evaluated over the coordinates of the particles so that the use of subsidiary conditions is avoided. Effects omitted in the random-phase approximation are included and the final results extend continuously over plasma and particle modes and should be valid in the range of densities encountered in real metals. The results agree closely with those of Nozières and Pines, and of Hubbard obtained by more elaborate methods.

11184 ON THE SCREENING OF MAGNETIC INTERACTION BY DEGENERATE FREE ELECTRONS.
N.Takimoto.
Progr. theor. Phys. (Japan), Vol. 24, No. 5, 923-48 (Nov., 1960).

For previous work, see Abstr. 20859 of 1960. A detailed investigation is made on the self-consistent determination of the vector potential due to a magnetic point dipole imbedded in a medium of degenerate free electrons. The Thomas–Fermi method shows that the screening by an induced electric current is Landau diamagnetic, and practically negligible. A dynaminal method is then applied to the same problem so as to investigate the effect of a flip motion of the point dipole on the screening. In this case another type of the screening arises which is due to the inability of some electrons to follow the non-adiabatic change of force induced by the flip motion. Some discussion is given of the discrepancy between the result and that of Abrahams (Abstr. 5509 of 1955) and of Bohm and Pines (Abstr. 5379 of 1951). The derived potential is used for the calculation of the spin–lattice relaxation time in ferromagnetic metals, and Kasuya's (Abstr. 7181 of 1955) estimation of its order of magnitude is proved to be reasonable. Its temperature dependence is discussed.

11185 THE EFFECT OF TEMPERATURE ON THE ANGULAR CORRELATION OF γ-RAYS EMITTED DURING ELECTRON–POSITRON ANNIHILATION IN BISMUTH.
I.Ya.Dekhtyar and V.S.Mikhalenkov.
Dokl. Akad. Nauk SSSR, Vol. 136, No. 1, 63-5 (Jan., 1961). In Russian.

For abstract, see Abstr. 6095 of 1961. [English translation in: Soviet Physics–Doklady (USA), Vol. 6, No. 1, 31-2 (July, 1961)].

11186 ULTRASONIC CYCLOTRON RESONANCE IN GALLIUM. B.W.Roberts.
Phys. Rev. Letters (USA), Vol. 6, No. 9, 453-5 (May 1, 1961).

Cyclotron resonance was observed in the absorption at 1.5°K of 115 Mc/s longitudinal and 116 Mc/s shear sound waves by a very pure single crystal of gallium, the electronic mean free path being about 1 cm. Geometric resonances were also observed. L.Mackinnon

11187 INFRARED CYCLOTRON RESONANCE IN N-TYPE InAs AND InP. E.D.Palik and R.F.Wallis.
Phys. Rev. (USA), Vol. 123, No. 1, 131-4 (July 1, 1961).

Cyclotron resonance of conduction electrons in InAs and InP was measured in the far infrared spectral region. The effective masses obtained for InAs show a variation with magnetic field indicative of the nonparabolic nature of the conduction band of this material.

11188 CYCLOTRON RESONANCE AND DE HAAS–VAN ALPHEN OSCILLATIONS OF AN INTERACTING ELECTRON GAS. W.Kohn.
Phys. Rev. (USA), Vol. 123, No. 4, 1242-4 (Aug. 15, 1961).

An electron gas with short-range interactions is considered in the presence of a uniform magnetic field. It is shown that (1) the cyclotron resonance frequency is independent of the interaction; (2) for a two-dimensional gas, the de Haas–van Alphen period is independent of the interaction. The low-lying excited states are briefly discussed.

CYCLOTRON AND PARAMAGNETIC RESONANCE IN DEFORMED CRYSTALS. See Abstr. 10178

11189 INTERACTION OF SLOW ELECTRONS WITH INSULATING CRYSTALS. II. COMPARISON OF ELECTRON AND PHOTON ABSORPTION COEFFICIENTS FOR KCl AND KBr.
W.J.Fredericks and C.J.Cook.
Phys. Rev. (USA), Vol. 121, No. 6, 1693-8 (March 15, 1961).

For Pt I, see Abstr. 7573 of 1961. The electron absorption coefficient for pure KCl and additively coloured KCl and KBr was measured in the energy range from 0.2 to 12 eV. These data are compared with photon absorption measured in the same crystals in the energy range from 1.2 to 6.5 eV and with published optical and photoemission data above 6.5 eV. Certain imperfection interactions were found at corresponding photon and electron energies. The surface transition layer, even for pure KCl, was observed to contain F and V_3 centres. There was no evidence of direct electron–exciton interactions. The valence band of KCl was observed to be 8.6 ± 0.2 eV below the vacuum level; this agrees with the measurements of Eby, Teegarden, and Dutton. Upon electron bombardment, an optical absorption near the first fundamental band was found to develop. Its characteristics do not coincide with any of the absorption bands previously reported in this energy region.

DEFECT PROPERTIES

11190 STRAIN ENERGY OF DISLOCATIONS IN ANISOTROPIC CRYSTALS. B.K.Agrawal and G.S.Verma.
Physica (Netherlands), Vol. 27, No. 4, 413-14 (April, 1961).

The strain-energy factors for the various dislocations in the face centred crystals were computed as a function of temperature. Detailed results are given for copper, silver and aluminium; these indicate that the strain energy of a pure edge dislocation is always greater than that of the pure screw and the strain energy of the mixed dislocation always lies between these two values.

R.Bullough

11191 DETERMINATION OF THE FORMATION ENERGY OF THERMAL VACANCIES IN BINARY ALLOYS.
S.D.Hertsriken and B.P.Slyusar.
Ukrayin. fiz. Zh. (USSR), Vol. 3, No. 1, 140-2 (1958). In Ukrainian.

11192 THERMAL VACANCIES IN METALS AND ALLOYS. S.D.Hertsriken and B.F.Slyusar.
Ukrayin. fiz. Zh. (USSR), Vol. 4, No. 2, 137-51 (1959). In Ukrainian.

The method of measuring the electrical resistance and the thermal expansion over a wide temperature range was employed to determine the energy of formation of thermal vacancies E_v in Au, Cu, Ag, Al, Pb, Zn, Cd and Sn, as well as in binary alloys with an Ag or Zn base, in which the second component is a small addition Ag or Zn base, in which the second component is a small addition (1 at. % or less: Ag + 0.48% Sn, Ag + 0.68% Cd, Ag + 0.58% In, Ag + 0.84% In, Ag + 0.90% Cu, Ag + 1.02% Au, Zn + 0.33% Cd, Zn Zn + 0.53% Cd, Zn + 0.37% Ag, Zn + 0.58% Ag). The pre-exponential factor κ in the formula connected with the change in entropy is calculated for the investigated metals. The relative number of vacancies near the melting point (in the solid state) and the specific resistance ρ_B of 1% of the vacancies are calculated. Small additions were found to lower the energy of vacancy formation, as compared with pure metal, and to increase considerably the concentration of vacancies, ρ_B being decreased at the same time. For almost all the investigated metals $E_v/E_{sd} \cong 0.3-0.4$: for pure metals $E_v/E_{sub} \cong 0.2$, where E_{sd} and E_{sub} are, respectively, the energy of self-diffusion activation and the energy of sublimation.

11193 SCREENED IMPURITY POTENTIALS IN METALS. E.C.McIrvine.
J. Phys. Soc. Japan, Vol. 15, No. 5, 928 (May, 1960).

It is pointed out that the potential around an impurity in a metal, calculated in the Thomas–Fermi model by Takimoto's method (Abstr. 20859 of 1960), must, besides being exponentially screened, have in general an oscillating behaviour. L.Pincherle

11194 IMPURITY TRAPPED INTERSTITIALS AND THE LOW TEMPERATURE ANNEALING STAGES OF IRRADIATED COPPER. R.R.Hasiguti.
J. Phys. Soc. Japan, Vol. 15, No. 10, 1807-14 (Oct., 1960).

A semi-empirical method is developed to evaluate interaction energies of close impurity-atom–interstitial pairs. It is found that an undersize impurity atom provides a deep trap for an interstitial, while an oversize impurity atom furnishes several shallow traps with different interaction energies. These results are applied to the annealing temperature problem of irradiated copper. Stage II is interpreted as due to the liberations and annihilations of several kinds of shallow trapped interstitials, and stage III is explained as due to the liberations and annihilations of deep trapped interstitials.

11195 INTERSTITIAL DEFECTS IN LiH AND NaCl IRRADIATED AT LOW TEMPERATURES.
F.E.Pretzel and R.L.Petty.
Phys. Rev. (USA), Vol. 123, No. 2, 464-5 (July 15, 1961).

Expansions of the lattice parameters of both LiH and NaCl exposed to β-radiation at 77° and 245°K were observed using a vacuum X-ray diffractometer stage operated at 77°K. The source of the β-radiation was 5.56% LiT contained in a LiH crystal which was ground and mixed with NaCl in the samples. The LiH lattice parameter increased 0.0020 ± 0.0007 A in three samples. This result is consistent with density measurements and with the formation of interstitial of He^3 atoms in the LiH lattice. The NaCl lattice parameter increased 0.0061 ± 0.0009 A even though the average β does for the NaCl was less than 1% of that in the Li(H,T) and tritium β-particles with maximum energy cannot produce direct displacements in NaCl. A mechanism is proposed for the production of Cl^- interstitials and vacancies (Frenkel defects) in NaCl which is similar to one proposed by Klick (Abstr. 17963 of 1960) for the production F and H centres. This mechanism is related to observations of production of α-centres in alkali halides irradiated at low temperatures.

11196 CRYSTAL "DOPING" BY ION BOMBARDMENT. F.M.Rourke, J.C.Sheffield and F.A.White.
Rev. sci. Instrum. (USA), Vol. 32, No. 4, 455-6 (April, 1961).

A 180° 30 in. radius magnetic analyser is shown to have applications to: (1) mass analysis of samples of less than 10^{-16} g (2) neutron cross-section measurement where impurities introduced by reagents and self-shielding are eliminated and a high enrichment is attained; (3) lattice diffusion studies to test the validity of $D = D_0 \exp(-\epsilon/kT)$ on a microscopic scale; (4) doping single-crystal Si with group III and group V impurities to form p–n and n–p structures; heavy doping ($\sim 10^{18}$ atoms/cm^3) is achieved owing to the shallow depth of doped region.

G.C.Willia

INVESTIGATION OF ACTIVATOR DISTRIBUTION IN NaI:Tl CRYSTALS. See Abstr. 11542

11197 OBSERVATION OF LAYER STRUCTURE IN DISLOCATION FREE SILICON CRYSTALS WITH THE USE OF X-RAY ANOMALOUS TRANSMISSION.
Z.Ishii, T.Furuoya, Y.Sasaki and K.Kohra.
J. Phys. Soc. Japan, Vol. 15, No. 1, 206-7 (Jan., 1960).

The layer structure in silicon single crystals previously observed by Dash (Abstr. 7598 of 1959), using a copper decoratio technique, was observed by X-rays using anomalous transmissio Comparative photographs using the copper decoration technique and the X-ray method are presented. R.Bullo

11198 LATTICE DISTORTION DUE TO ISOTOPES IN SOLID HELIUM. P.G.Klemens and A.A.Maradudin.
Phys. Rev. (USA), Vol. 123, No. 3, 804-6 (Aug. 1, 1961).

Observations of the thermal resistivity of solid helium conta He^3 isotopes have indicated that the phonon scattering cross-sect of the isotope is three times larger than the theoretical value obtained by considering only the mass-difference. Using as a mo a helium atom in the potential well formed by its neighbours, and taking account of the zero-point energy of that atom and of the strain energy in the surrounding solid when the atomic cell is expanded, it is shown that around a He^3 isotope the lattice suffers an outward distortion of about 1-2%. This distortion can account the discrepancy in the phonon scattering cross-section.

11199 GENERAL LATTICE STATICAL THEORY OF DISLOCATIONS. E.Fues and F.Wahl.
Z. Naturforsch. (Germany), Vol. 16a, No. 4, 385-94 (April, 1961) In German.

A general theory is formulated which includes the treatment singularities and covers screw as well as edge dislocations. Particular applications are dealt with only briefly in view of previously published calculations concerning edge dislocations i KCl crystals (see Abstr. 6267 of 1959, 1592 of 1960 and 3671 of 1961). Simplifying assumptions are made to extend the theory to the case of a crystal with arbitrarily many dislocation lines. Finally an expression is developed for the calculation of the stra energy associated with dislocations. J.W.Le

11200 ACCUMULATIONS OF DISLOCATIONS IN CRYSTALS CONTAINING IMPURITIES.
V.N.Rozhanskii and V.L.Indenbom.
Dokl. Akad. Nauk SSSR, Vol. 136, No. 6, 1331-4 (Feb. 21, 1961). In Russian.

Bilby and Entwisle [Acta metallurgica (Internat.), Vol. 4, 25 (1956)] have compared the theoretical distribution of dislocations piled-up against an obstacle, with some rows of etch-pits observ in α-brass. Agreement is variable. An alternative theoretical scheme is here developed, in which the dislocations have become immobile. Each dislocation is assumed to attract an atmosphere impurities, after taking its place in the queue, and is then locked during the addition of its successors. The solution obtained is shown to fit fairly well one of Bilby and Entwisle's micrographs, and two more of cadmium crystals, obtained by the authors. [En translation in: Soviet Physics – Doklady (USA)]. I.D.C.Gur

11201 REDUCTION OF COHESION IN IONIC CRYSTALS BY DISLOCATIONS. J.L.Gilman.
J. appl. Phys. (USA), Vol. 32, No. 4, 738 (April, 1961).

It is suggested the dislocations in a crystal can substantiall

re ɛe its cohesive strength, thus, after a small amount of plastic fl has occurred just in front of a crack tip, the crack can move th igh the weakened material. The plausibility of this hypothesis w tested by passing cracks through prestrained crystals of LiF.
R.Bullough

.202 GRAPHITIZATION STRESS IN POLYCRYSTALLINE CARBON AS AN ORIGIN OF DISLOCATIONS.
T ɪuzuku.
J ays. Soc. Japan, Vol. 15, No. 8, 1373-9 (Aug., 1960).
Stress analysis was made on each of the spherical and the c ɪdrical (filamentarily textured) polycrystals in which the c ɔn crystallites are aligned with the basal planes parallel to t external surface. These two models have the structure of pyroly- t ɛarbon particles and of fibrous soft coke respectively. It is ɛ vn that in either of these two cases about 3×10^{10} dynes/cm^2 t ion in the a-direction and about 0.9×10^{10} dynes/cm^2 compress- i in the c-direction can be produced by heat treatment at 2500°C, ɔh are enough to buckle the crystal lattice at the stress concen- t ions of 5 ~ 20 times, and may lead to the generation of disloca- t s. From the corresponding strain distribution curves, the (erion on the stress relaxation by these dislocations was deter- ı ed in connection with the crystallite size, which may give a ı ɪsure of distinction between the so-called soft and hard carbons.

1203 HELICAL DISLOCATIONS IN CRYSTALS OF LEAD IODIDE. A.J.Forty.
l. Mag. (GB), Vol. 6, 587-97 (April, 1961).
The appearance of "zig-zag" dislocation lines during the ɔmposition of crystals of lead iodide in the electron microscope ɔe explained by the climb of existing dislocations into a ɛened helical form. The simple zig-zags are often distorted ɔ cusped and looped forms and it is shown how these distortions y be accounted for by the elastic interaction between neighbour- segments of the helices. Such internal re-arrangement within ices is possible only as a result of the marked anisotropy of climb and glide processes in these particular crystals. The nb of arrays of dislocations leads to interactions between ghbouring helices. Some examples of such interaction are ɛcribed and it is shown how these may lead to the formation of lated loops of dislocation and double helices. An examination of nature of loops formed in this way suggests an interesting ɜsibility for the creation of new regenerative sources of glissile ɔlocations.

11204 DISLOCATION RELAXATION PHENOMENA IN OXIDE CRYSTALS. R.Chang.
appl. Phys. (USA), Vol. 32, No. 6, 1127-32 (June, 1961).
The dislocation relaxation of MgO and Al_2O_3 crystals was ɯdied by means of anelastic measurements. The experimental ata are analysed according to the theory of Seeger, Donth, and Pfaff Abstr. 4432 of 1958). It is shown that the ratio of Peierls force to hear modulus is about 2×10^{-5} for MgO and possibly also for Al_2O_3. Comparison of the dislocation relaxation phenomena of oxides nd metals indicates, rather surprisingly, that the ratio of Peierls ɔrce to shear modulus in oxides is about an order of magnitude maller than that in f.c.c. metals.

11205 MOIRÉ PATTERNS AND DISLOCATIONS IN MICA. I.Sugar.
Z. Naturforsch. (Germany), Vol. 16a, No. 2, 221-3 (Feb., 1961).
Moire patterns, dislocation lines and extinction contours were ɔbserved during an investigation with the electron microscope of he degree of perfection of thin cleaved sheets of mica. These eatures are illustrated by ten micrographs and briefly discussed. A method of obtaining thin sheets of mica of fairly uniform thick- ness and free from bending was developed. V.E.Cosslett

11206 DENSITY OF ISLOCATIONS, DUE TO DEFORMATION, IN Ni, Ag AND Al. S.D.Hertsriken and N.N.Novýkov.
Ukrayin. fiz. Zh. (USSR), Vol. 3, No. 5, 695-6 (1958). In Ukrainian.

STRUCTURAL ANOMALIES IN POTASSIUM FERROCYANIDE TRIHYDRATE CRYSTALS. See Abstr. 11351

11207 DISLOCATIONS IN Si SINGLE CRYSTALS. T.Furuoya and Y.Sasaki.
J. Phys. Soc. Japan, Vol. 15, No. 1, 205-6 (Jan., 1960).
Describes the behaviour of dislocations in single crystals subjected to pulling, rotation and thermal shock. R.F.Peart

11208 X-RAY OBSERVATIONS ON CLEAVAGE FACES OF LiF SINGLE CRYSTALS. M.Yoshimatsu and K.Kohra.
J. Phys. Soc. Japan, Vol. 15, No. 10, 1760-70 (Oct., 1960).
Cleavage faces of LiF single crystals were studied by the Berg–Barrett method of X-rays. (i) Boundary lines of subgrains with small tilt angle showed the intensity enhancement. The intensity enhancement was also seen for boundaries lying close to the surface. (ii) As to deformations produced by cleaving, more information, such as slip directions, is obtained than in etch-pit photographs. (iii) Furthermore, outcrops of individual dislocations arrayed in a boundary line or scattered in the interior of a grain were resolved. Dislocation half-loops lying close to the surface in a slip line were also observed. In each type of defect above mentioned the direction of the Burgers vector was determined.

11209 THE DETERMINATION OF THE DISLOCATION DENSITY IN STRAINED METALS FROM MICRO-HARDNESS MEASUREMENTS. S.D.Hertsriken and M.M.Novýkov.
Ukrayin. fiz. Zh. (USSR), Vol. 41, No. 2, 247-52 (1959).
In Ukrainian.
An attempt is made to establish a connection between the value of the interaction dislocation stress and the value of the tensile strength of a metal, and on the basis of this connection to compute the dislocation density in the metal at a given strain. Since, the tensile strength of the sample is connected with its hardness, it is found possible to compute the dislocation density in the strained sample from the value of its hardness. The dislocation densities are calculated for aluminium, copper, silver and nickel at various degrees of strain by torsion. The dislocation density values obtained are compared with those computed from dilatometric measurements. The difference in the dislocation density values obtained by various methods is quite allowable in determinations of this type. Applying published data on the dependence of the change in the hardness of aluminium and copper on the degree of compressive strain, the authors computed the values of the dislocation densities in these metals. In these cases too, reasonable values were obtained for the dislocation density.

11210 ELECTRON MICROSCOPE INVESTIGATIONS OF THE FORMATION OF DISLOCATIONS DURING RECRYSTALLIZATION. F.Granzer and G.Haase.
Z. Phys. (Germany), Vol. 162, No. 5, 468-82 (1961). In German.
The theories for the production of dislocations in metal lattices are reviewed. Single crystals of aluminium, prepared by the electrolytic thinning of foils, were plastically deformed and studied by electron microscope and diffraction methods. The results clearly indicate that during deformation the crystallites are ordered into chains, a process, however, which distorts the lattice into polygonally shaped regions. R.Reed

11211 OBSERVATIONS OF DISLOCATION NETWORKS IN AN ALLOY OF BODY-CENTERED CUBIC LATTICE BY ELECTRON MICROSCOPY.
S.Nenno, T.Saburi, M.Tagaya and Z.Nishiyama.
J. Phys. Soc. Japan, Vol. 15, No. 8, 1409-12 (Aug., 1960).
Electron microscopic observations were made on dislocation networks in thin foils of 55% Cr–Fe alloy annealed at 720°C after cold working. Dislocation cross-grids, hexagonal networks and networks of irregular shape were observed. From the presence of three-fold nodes, it is suggested that Burgers vectors of type [100] may be stable as well as those of type $\frac{1}{2}[111]$.

11212 DEFECT CHANNELS ALONG THE OPTIC AXIS OF QUARTZ. H.H.Pfenninger and F.Laves.
Naturwissenschaften (Germany), Vol. 48, No. 1, 23 (1961).
In German.
After electrolysis with gold or silver electrodes, electron micrographs of replicas taken perpendicular to the optic axis showed a raised bristle-like structure originating at the ends of the channels.
J.E.Caffyn

11213 THE DISLOCATION ETCH PITS OF CdS CRYSTALS. J.Nishimura.
J. Phys. Soc. Japan, Vol. 15, No. 4, 732 (April, 1960).
Photographs are reproduced showing the effect of etching in thiourea–HCl after various heat-treatments. Conclusions are drawn regarding the configuration of dislocations. A.R.Stokes

11214 THE QUESTION OF REVEALING DISLOCATIONS IN GERMANIUM BY ETCHING.
V.M.Vasilevskaya and E.G.Miselyuk.
Fiz. tverdogo Tela (USSR), Vol. 3, No. 2, 429-35 (Feb., 1961).
In Russian.

An experimental study was made of the following factors affecting the revealing of dislocations in Ge by etching: crystal orientation [(100), (110) and (111) planes]; composition of the etchant (3 compositions); time of etching; effect of etchants on screw and edge dislocations. [English translation in: Soviet Physics—Solid State (USA)]. R.F.S.Hearmon

11215 THE FORMATION OF DISLOCATIONS ON ELECTRICAL BREAKDOWN IN IONIC CRYSTALS.
M.P.Shaskol'skaya, Van Yan'-vén' [Wang Yen-wên] and Gu Shchu-chzhao'.
Fiz. tverdogo Tela (USSR), Vol. 3, No. 2, 658-9 (Feb., 1961).
In Russian.

Specimens of LiCl, KCl and NaCl were subjected to electrical breakdown and subsequently etched. In LiF the dislocations occur along [110] and [100], in KCl along [100]; and in NaCl along [110]. [English translation in: Soviet Physics — Solid State (USA)]. R.F.S.Hearmon

11216 POLYGONIZATION IN BENT ZINC CRYSTALS.
P.P.Sinha and P.A.Beck.
J. appl. Phys. (USA), Vol. 32, No. 7, 1222-6 (July, 1961).

High-purity zinc crystals were grown from the melt by the soft mould technique, and bent in such a way that $[0\bar{1}10]$ was parallel to the bending axis and the $[21\bar{1}0]$ slip direction enclosed approximately 45° with the bending radius. A dislocation etching technique was developed, which reveals the edge dislocations introduced on bending, without the necessity of decoration. It was found that crystals bent either at room temperature or at liquid nitrogen temperature had approximately two-thirds of the edge dislocations arranged in low-angle tilt boundary segments. The fact that no observable change occurred in the dislocation structure on annealing up to 225°C for 5000 min suggests that the observed low-angle boundaries were formed directly on bending rather than by a thermally activated polygonization process, which might have been thought to take place at room temperature in the interval between bending and etching.

11217 DISLOCATIONS AND STACKING FAULTS IN ALUMINIUM NITRIDE.
P.Delavignette, H.B.Kirkpatrick and S.Amelinckx.
J. appl. Phys. (USA), Vol. 32, No. 6, 1098-1100 (June, 1961).

Dislocations in thin platelets of aluminium nitride grown from the vapour phase appear to be of two types. Some are dissociated into partials of the Shockley type; others are undissociated. A model is given for both types. The stacking fault associated with the dissociated dislocations consists of one lamella of the sphalerite structure. The stacking fault energy is deduced from the width of the ribbons and from the shape of the extended nodes; its value is $\gamma \cong 4$ ergs/cm^2.

"CORRELATION OF STACKING FAULT FREQUENCY WITH LECTURE TRANSITION IN HIGH-PURITY SILVER".
See Abstr. 10279

11218 ON THE MECHANICAL AND THERMAL STABILITY OF LOW-ANGLE BOUNDARIES IN ZINC SINGLE CRYSTALS. S.Weissmann, M.Hirabayashi and H.Fujita.
J. appl. Phys. (USA), Vol. 32, No. 6, 1156-64 (June, 1961).

The mechanical and thermal stability was studied by methods combining metallographic techniques with X-ray reflection microscopy and diffraction analysis. It was found that low-angle boundaries perpendicular to the basal plane do not offer any appreciable resistance to a shearing force parallel to the basal plane if they are pure tilt boundaries, but are substantial barriers if they are asymmetrical. If the external force exceeds a critical value, these asymmetrical low-angle boundaries become sites where fracture may occur. The strengthening effect of the asymmetrical low-angle boundaries is attributed to the effective stress field of the screw dislocations, which are mechanically stabilized by the edge dislocations. The stress field of the screw dislocations is also responsible for the thermal instability of the asymmetrical low-angle boundaries, which on annealing are gradually converted into pure tilt boundaries. A coarse substructure established after annealing is thermally very stable. On solidification after partial melting of the crystal, the coarse substructure is re-established, whereas the fine substructure is entirely modified.

Diffusion

11219 ANALYTIC SOLUTION OF THE DOUBLE-DIFFUSIO PROBLEM. K.C.Nomura.
J. appl. Phys. (USA), Vol. 32, No. 6, 1167-8 (June, 1961).

An analytic solution for the process of double diffusion of impurities into a semiconductor shows that it may be considered as the superposition of two independent diffusions. P.A.Wal

11220 THEORY OF THE SELF-DIFFUSION COEFFICIENT IN CUBIC METALS.
G.M.Pound, W.R.Bitler and H.W.Paxton.
Phil. Mag. (GB), Vol. 6, 473-83 (April, 1961).

The kinetics of diffusion in cubic metals is treated in terms of statistical mechanics from the point of view of absolute rate theory. An approximate description of the activated state leads to the conclusion that in the two degrees of freedom orthogonal to the jump direction only the lower vibrational energy levels are occupied. This circumstance gives rise to a negative contributio to the experimental entropy of activation for diffusion in solids which is negligible for the vacancy mechanism but very appreciab for the ring mechanism. It is suggested that a low D_o, perhaps of the order of 10^{-4} cm^2/sec, is an experimental criterion for the four-atom ring mechanism and that the self-diffusion in pure chromium and uranium (b.c.c.) may occur by this mechanism. Further, a low Arrhenius frequency factor is predicted for all thermally activated processes in solids which require simultaneo jump of n atoms, e.g. in certain movements of dislocation loops.

11221 THE INVESTIGATION OF DIFFUSION IN METAL OXIDES BY MEANS OF RADIOACTIVE TRACERS.
N.S.Gorbunov and V.I.Izvekov.
Uspekhi fiz. Nauk (USSR), Vol. 72, No. 2, 273-306 (Oct., 1960).
In Russian.

A review of experimental techniques and methods for the determination of diffusion coefficients in metals and metal oxides. Data for the diffusion of metals in simple and complex metallic oxides is tabulated. [English translation in: Soviet Physics — Uspekhi (USA), Vol. 3, No. 5, 778-97 (March-April, 1961)]. R.F.Pea

THE MOBILITY OF ATOMS IN METALS IN THE REGION OF RECRYSTALLIZATION TEMPERATURES. See Abstr. 11585

11222 INVESTIGATION OF THE TEMPERATURE DEPENDENCE OF ELECTRICAL TRANSPORT IN ALLOYS BASED ON REFRACTORY METALS.
M.D.Smolin and I.N.Frantsevich.
Dokl. Akad. Nauk SSSR, Vol. 136, No. 1, 81-3 (Jan. 1, 1961).
In Russian.

For abstract, see Abstr. 4992 of 1961. [English translation i Soviet Physics—Doklady (USA), Vol. 6, No. 1, 66-7 (July, 1961)].

11223 SELF-DIFFUSION COEFFICIENT IN SOLID ARGON.
R.Fieschi, G.F.Nardelli and A.R.Chiarotti.
Phys. Rev. (USA), Vol. 123, No. 1, 141-7 (July 1, 1961).

Self-diffusion in argon crystals is discussed on the basis of t mobility of vacancies, and in the scheme of the "absolute rate the Detailed calculations are made for the heat of activation Q and fo the pre-exponential factor D_o including quantum corrections. The change of potential energy is evaluated first by minimizing the la energy with respect to the displacement of the four atoms around the diffusing particle, next by calculating first-order elastic rela tion of the entire lattice. The change of vibrational properties is evaluated in the Einstein approximation. Including the contributio for the hole formation, the values $D = 4.20 \times 10^{-4}$ cm^2 sec^{-1}, $Q = 13.85 \times 10^{-2}$ eV, are found at $T = 80°K$; the zero-point energy contributes 5% to the heat of activation.

11224 GRAIN-BOUNDARY DIFFUSION.
A.E.Austin and N.A.Richard.
J. appl. Phys. (USA), Vol. 32, No. 8, 1462-71 (Aug., 1961).

The diffusion of nickel into grain boundaries of various tilt angles in copper bicrystals was studied. The concentration conto from the grain boundary and the lateral lattice diffusion were measured by means of electron-probe microanalysis. The produ of grain-boundary width and diffusion coefficient were calculated and comparisons were made with theoretical solutions. The grai boundary coefficient is concentration dependent above 3% nickel i a 45° tilt boundary. With lower tilt angles, the coefficient is concentration dependent above 0.5% nickel.

11225 X-RAY DIFFRACTION STUDY OF INTERDIFFUSION IN Cu—Ni POWDER COMPACTS.
Fisher and P.S.Rudman.
Appl. Phys. (USA), Vol. 32, No. 8, 1604-11 (Aug., 1961).

Interdiffusion in Cu—Ni powder compacts was studied by X-ray fraction line shape analysis. Analogues to concentration—netration plots are obtained. Results obtained at 750°, 850°, 950°, d 1050° C are compared with the conclusion that a single diffusion chanism dominates in the range 750-950° C with an activation ergy of about 26 kcal/mole, and it is concluded that the dominant chanism is grain boundary diffusion. At 1050° C a new chanism with a higher activation energy dominates, and it is ncluded to be bulk diffusion. Metallographic observation revealed it prior to appreciable interdiffusion, the Cu, presumably by rface diffusion, envelops the Ni particles with subsequent inter-fusion between the Ni-rich core and the Cu-rich shell. This nfiguration is idealized to a concentric spheres model permitting gorous solution of the diffusion equation for constant diffusion efficient. The result of the calculation according to this new odel and according to other authors' models are compared with e experimental results with the general certification of the ncentric spheres model. The concentric spheres model is shown predict that the rate of homogenization in the Cu—Ni system ould be independent of the Cu particle size.

DIFFUSION IN A SILICATE GLASS. See Abstr. 11332

11226 EFFECT OF HYDROSTATIC PRESSURE ON SELF-DIFFUSION OF IRON IN IRON ALLOYS WITH SMALL DDITIONS OF ALUMINIUM.
.D.Hertsriken and M.P.Pryanyshnykov.
krayin. fiz. Zh. (USSR), Vol. 3, No. 5, 651-8 (1958). In Ukrainian.

The effect of volume pressure (effected by means of argon in a pecial chamber) up to 150 kg/cm² on the iron diffusion parameters as investigated in iron alloys with 0.27 and 0.39 per cent of luminium. The temperature interval of the investigation was 100-1250° C. It was shown that the pressure causes a sharp de-rease in the self-diffusion activation energy and perceptibly raises he rate of self-diffusion. Up to a pressure of 100 kg/cm², linearity of ln D = f(P) is noted.

11227 PERMEATION OF HYDROGEN AND DEUTERIUM THROUGH A NICKEL MEMBRANE IN THE 250-600° C EMPERATURE RANGE. Yu.I.Belyakov and N.I.Ionov.
Zh. tekh. Fiz. (USSR), Vol. 31, No. 2, 204-10 (Feb., 1961). In Russian.

For abstract, see Abstr. 6114 of 1961. [English translation in: oviet Physics—Technical Physics (USA), Vol. 6, No. 2, 146-50 Aug., 1961)].

11228 DIFFUSION ALONG SMALL-ANGLE GRAIN BOUNDARIES IN SILICON.
H.J.Quiesser, K.Hubner and W.Shockley.
Phys. Rev. (USA), Vol. 123, No. 4, 1245-54 (Aug. 15, 1961).

Diffusion fronts in samples containing grain boundaries are spike shaped. Velocity of spike advance and angle between spike and boundary are measured. The "spike-velocity method" of analysis permits evaluation of two effective widths, W_D and W_o, which describe the diffusion properties of the boundary. This method has been used to analyse data on phosphorus diffusion into boron-doped silicon at 1200° C and 1050° C. It is concluded that an enhanced diffusion current flows along each dislocation of the grain boundary over a cross-section less than one Burgers-vector square. The diffusion current density is about 300 000 times that of the bulk. This corresponds to an energy of 1.5 eV by which grain boundary diffusion is favoured over the bulk diffusion. This enhancement is believed to be caused by enrichment of phosphorus and also partly by the extra concentration of vacancies near the dislocation cores. Some possible extensions of the studies to include saturation effects at the dislocation cores are discussed.

Colour Centres

11229 EXCITED STATES OF A LOCAL ELECTRON CENTRE INTERACTING WITH A QUANTIZED FIELD AT ARBITRARY VALUES OF THE COUPLING CONSTANT. II. APPLICATION TO THE THEORY OF LIGHT ABSORPTION BY LOCAL ELECTRON CENTRES. V.M.Buimistrov.
Ukrayin. fiz. Zh. Dodatok (USSR), Vol. 3, No. 2, 21-31 (1958). In Ukrainian.

The wave-functions obtained in Pt I (Abstr. 9112 of 1958) are applied to the calculation of the coefficient of light absorption by local centres at arbitrary values of the coupling constant. A detailed calculation is presented for the F-centre. The product of the maximum value of the absorption coefficient and the half-bandwidth of the F-centre absorption proved to depend on the temperature in crystals with fairly high values of the dielectric constant. Crystals were chosen (TeCl, TeBr, TeI, $PbCl_2$) in which intermediate coupling occurred for the impurity electron with changes in the effective mass μ of the band electron over a wide range (from several electron masses m and less). At $\mu = 4m$ the energy corresponding to the maximum absorption lies within 0.4–0.2 eV.

11230 COLOR CENTERS AND RADIATION-INDUCED DEFECTS IN Al_2O_3. P.W.Levy.
Phys. Rev. (USA), Vol. 123, No. 4, 1226-33 (Aug. 15, 1961).

The peak energy E_o and full width U, in eV, of the colour centres in Al_2O_3 before irradiation are: $E_o = 5.45$, $U = 0.6$; $E = 4.84$, $U = 0.54$; with an indication and a band at $E_o > 6.2$, $U > 0.4$. Irradiation of 3×10^4 r produces saturation of the gamma-ray-induced bands which occur at $E_o = 5.45$, $U = 1.25$; $E_o = 3.08$, $U = 1.50$; and probably an additional band at $E_o \approx 4.28$, $U = 0.70$. Reactor irradiation produces band at $E_o = 6.02$, $U = 0.60$; $E_o = 5.35$, $U = 0.40$; $E_o = 4.85$, $U = 0.54$; $E_o = 4.21$, $U = 0.80$; $E_o = 3.74$, $U = 0.88$; $E_o = 2.64$, $U = 0.64$; and $E_o = 2.00$, $U = 0.44$. Curves of colour-centre concentration versus irradiation time for the reactor-induced bands at $E_o = 6.02$, $E_o = 5.35$, and $E_o = 4.85$ can be accurately represented by a saturating exponential plus a linear increase. This behaviour is predicted by a simple theory which assumes that the colour centres are formed by the colouring of defects present prior to and increased by irradiation and possibly by the colouring of additional centres formed only by radiation damage. The measured rate of defect formation could be consistent with current radiation damage theories; however, several inaccurately known parameters preclude a meaningful comparison.

11231 COLOR CENTERS IN ZnS SINGLE CRYSTALS.
A.Halperin and R.Pinker.
J. chem. Phys. (USA), Vol. 34, No. 6, 2031-4 (June, 1961).

Absorption bands induced in ZnS crystals by u.v. (0.366 μ) are described. The two main absorption bands peaked at or below 0.6 μ and at 1.2 μ. Two weaker bands at 0.8 and 1.35 appear as shoulders of the main bands. Thermal and optical bleaching properties are also described, and the results are briefly discussed in light of a formerly proposed model.

11232 PULSE PHOTOCONDUCTIVITY OF ADDITIVELY COLORED KBr. M.Onuki and H.Ohkura.
J. Phys. Soc. Japan, Vol. 15, No. 10, 1862-71 (Oct., 1960).

The space-charge effect in the measurement of a photocurrent of additively coloured KBr was investigated by using the repeated pulsive illumination and applying the d.c. and a.c. electric fields. The space charge polarization may arise from the accumulation of the electrons trapped in the surface states, the depth of which is about 0.3 eV. The condition for the absence of space-charge was ascertained to be realized by adopting the a.c. field and the pulsive illumination synchronized with plus and minus peaks of the a.c. field. The temperature-dependence of pulse photocurrent was measured by varying the duration of the pulsive illumination. The time constants of current-decay after switching-off of illumination were also observed. Three kinds of electron-traps were found, the one corresponding to an F centre and the other two to unknown centres. The activation energies for releasing the electrons trapped in these centres were estimated to be 0.44, 0.35 and 0.43 eV respectively. The growth and bleaching of optical absorption bands were investigated in relation to the above electron-traps. A detailed analysis for the trapping kinetics was made to apply to additively coloured KBr crystals.

11233 ON A CENTERS IN COLOURED KCl CRYSTALS.
H.Ohkura and K.Awane.
J. Phys. Soc. Japan, Vol. 15, No. 7, 1349-50 (July, 1960).

F band irradiation of KCl at room temperature (at 530 mμ to avoid A band overlap) produces the A band with peak at 2·23 eV at 90°K. Continued irradiation results in M and later R band formation the A band slowly decreasing. The oscillator strength for the A band is estimated as 0·5. G.F.J.Garlick

11234 SCATTERING OF NON-LOCALIZED EXCITONS ON F-CENTRES. Z.S.Kachlishvili.
Fiz. tverdogo Tela (USSR), Vol. 3, No. 2, 492-9 (Feb., 1961). In Russian.
For abstract, see Abstr. 10015 of 1961. [English translation in: Soviet Physics - Solid State (USA), Vol. 3, No. 2, 361-6 (1961)].

11235 ONE MECHANISM OF ELECTRON EXCITATION FOR A MODEL OF F-CENTRE AND EXCITON MOLECULAR ORBITS. A.A.Tsertsvadze.
Fiz. tverdogo Tela (USSR), Vol. 3, No. 2, 505-13 (Feb., 1961). In Russian.
For abstract, see Abstr. 10016 of 1961. [English translation in: Soviet Physics - Solid State (USA), Vol. 3, No. 2, 370-6 (1961)].

11236 ON THE F → F' CONVERSION IN THE PRESENCE OF A-, M-, R-, AND Z_1-CENTERS.
H.Ohkura, K.Awane and S.Miyamoto.
J. Phys. Soc. Japan, Vol. 15, No. 5, 934 (May, 1960).
Evidence for a decrease in optical quantum efficiency for the F → F' conversion in KCl single crystals, doped with strontium and containing other centres, is presented. J.E.Caffyn

11237 ON THE THEORY OF THE F-CENTRE. II. OPTICAL TRANSITIONS AND ABSORPTION BANDS.
M.Wagner.
Z. Naturforsch. (Germany), Vol. 16a, No. 3, 302-17 (March, 1961). In German.
From the reduction of the electronic problem to one of the interaction of a few physically real oscillators carried out in Pt I (see Abstr. 998 of 1961) a further calculation is made of the absorption spectrum of the F-centre. The derived half widths and temperature dependence of the F-band show good agreement with experiment. The first neighbouring band is also explicitly derived. Second order effects, e.g. those of lattice vibrations are left for later consideration. G.F.J.Garlick

11238 ELECTRONIC STRUCTURE OF THE F CENTER IN LiCl. R.F.Wood and J.Korringa.
Phys. Rev. (USA), Vol. 123, No. 4, 1138-44 (Aug. 15, 1961).
The electronic structure of the F-centre lattice defect in LiCl is investigated with calculations based on the usual model of the F-centre proposed by de Boer. The ground- and excited-state wave functions and energies of the trapped electron are determined by two different methods. First, the method of linear combination of atomic orbitals (LCAO) is used. This method is capable of yielding good results but the complexity of the necessary calculations is great. In an effort to avoid this complexity the method of vacancy-centred wave functions is investigated. Very simple wave functions are used in this method with satisfactory results. The coefficient of the hyperfine interaction of the F-centre electron with the nearest-neighbour lithium ion and the oscillator strength of the optical transition are calculated. The distortions of the lattice in the vicinity of the F-centre are calculated. A very small outward movement of the first and second nearest neighbours occurs in the ground state. The situation in the excited state is complicated by the "p-type" symmetry of the F-electron wave function. In this case, the two nearest-neighbour lithium ions located on the symmetry axis of the wave functions are found to undergo a large displacement outward from the vacancy. The other four nearest neighbours displace inward toward the centre of the vacancy. The results of the calculations are discussed and detailed comparisons with other work of a similar nature are given.

11239 RESOLVED ISOTROPIC HYPERFINE STRUCTURE OF THE ELECTRON PARAMAGNETIC RESONANCE ABSORPTION OF F-CENTERS IN NaH.
W.T.Doyle and W.L.Williams.
Phys. Rev. Letters (USA), Vol. 6, No. 10, 537-9 (May 15, 1961).
19 lines are resolved for commercial NaH powder. The values of the hyperfine interaction constant for the first and second shell are given and the corresponding moduli of the wave-functions at the nucleus are obtained from the line separation and the line-width respectively. J.E.Caffyn

11240 FORMATION MECHANISM OF F-CENTERS IN KCl SINGLE CRYSTALS HEATED IN POTASSIUM VAPOR.
H.Mizuno and M.Inoue.
J. Phys. Soc. Japan, Vol. 15, No. 1, 211 (Jan., 1960).
From optical measurements on crystals coloured by exposure of one face to potassium vapour at 500°C for 14 hr, it is concluded that the colour-centre concentration is exponentially dependent on depth, thus supporting a disordered interface diffusion mechanism for F-centre production. J.E.Caffyn

11241 ELECTRON-SPIN RESONANCE [E.S.R.] INVESTIGATIONS ON M CENTRES IN KCl.
H.Gross and H.C.Wolf.
Naturwissenschaften (Germany), Vol. 48, No. 8, 299-300 (1961). In German.
E.S.R. and absorption measurements were made on additively coloured KCl crystals irradiated for various lengths of time. As M centres were formed, the E.S.R. response decreased from that obtained with F centres alone, and increased on further irradiation as other centres appeared. It is concluded that the M centre in KCl is diamagnetic. J.Frank

11242 THERMAL BLEACHING OF COLOR CENTERS IN KCl CRYSTALS CONTAINING U CENTERS. M.Hirai.
J. Phys. Soc. Japan, Vol. 15, No. 7, 1308-15 (July, 1960).
From the study of thermal bleaching of the F, M and R_2 bands in KCl crystals containing U-centres, the behaviour of the hydrogen molecules produced from U-centres was examined. The hydrogen molecules do not react with F-centres but convert M-centres to U-centres by bimolecular reaction. Thermal bleaching of the Z_1 and Z_2 bands in KCl crystals containing divalent cations was also investigated. The Z_1 and Z_2 bands are thermally unstable at temperatures above 80°C, while they are stable up to 110° and 250°C respectively, in the crystal containing no U-centres. From these results, in KCl:Sr crystals it is supposed that Z_1-centres do not return to U-centres but form unknown centres by combining with the hydrogen molecules.

11243 DICHROISM OF Z_4 AND F BANDS. M.Ishiguro and N.Takeuchi.
J. Phys. Soc. Japan, Vol. 15, No. 10, 1871-5 (Oct., 1960).
To investigate the dichroic property of the Z_4 band, an experiment on anisotropic bleaching was made. It was found that the symmetry axis of Z_4 centre is parallel to the <110> direction and the Cole and Friauf's A model (Abstr. 616 of 1958 conforms with this symmetry. It was also found that there exists the same correlation in dichroism between F and Z_4 bands as that between F and M bands.

Radiation Effects

EFFECT OF IRRADIATION GROWTH ON THE CREEP OF URANIUM UNDER A UNIAXIAL LOAD. See Abstr. 11514

RADIATION-INDUCED DEFECTS IN Al_2O_3. See Abstr. 11230

INTERSTITIAL DEFECTS IN LiH AND NaCl IRRADIATED AT LOW TEMPERATURES. See Abstr. 11195

11244 RECOVERY OF ELECTRON RADIATION DAMAGE IN N-TYPE InSb. F.H.Eisen.
Phys. Rev. (USA), Vol. 123, No. 3, 736-44 (Aug. 1, 1961).
The production and recovery of electron radiation damage in n-type InSb was studied by means of Hall-coefficient and electrical-conductivity measurements. Irradiations were performed mainly at 80°K, since no recovery was observed between 4° and 80°K. The damage recovered in five well-defined stages with the recovery nearly complete at 320°K. Isochronal and isothermal recovery was monitored in each of the stages, allowing a determination of the activation energies for recovery and a study of the recovery kinetics. None of the recovery kinetics fit any simple models. There is evidence that the two lowest-temperature recovery stages involve the annihilation of close interstitial-vacancy pairs and that interactions of primary defects with impurities do not occur. However, the first-order kinetics expected for close-pair recovery is not explicitly observed. A possible explanation for the observed kinetics involving the independent annihilation of two types of close-pair configurations in the same stage with an electrostatic interaction between the interstitial and vacancy, is proposed.

12245 PRECIPITATION OF HELIUM ALONG DISLOCATIONS IN ALUMINUM. G.T.Murray.
J. appl. Phys. (USA), Vol. 32, No. 6, 1045-8 (June, 1961).
Helium was generated in an Al—0.1 at.% Li alloy by transmutation of the Li^6 atoms during neutron irradiation. During subsequent heating of the specimens, the helium appeared to precipitate in the form of small "bubbles". On using a dislocation

ıant it was found that (1) the regions of largest dislocation sity also contained the highest cavity density; (2) in some regions h dislocation etch pit was associated with a cavity, and (3) in er regions a series of cavities appeared to delineate the track of islocation. It is believed that the helium precipitates along the locations in the form of continuous or semicontinuous cylindrical ities.

11246 EVIDENCE FOR FOCUSING COLLISIONS IN IRRADIATED PLATINUM.
Quedl, P.Delavignette and S.Amelinckx.
ys. Rev. Letters (USA), Vol. 6, No. 10, 530-2 (May 15, 1961).

Pt foil 0.1 μ thick was annealed for 1 hr at 800°C to produce a asonable grain size, and then irradiated with doses up to 5×10^{16} n/cm^2 for times up to 5 hr. Electron microscopy vealed that the increase in the concentration of defect clusters as proportional to the dose and that preferential formation of fects occurred along coherent twin boundaries. R.F.Peart

11247 INFLUENCE OF DEFORMATION AND TEMPERATURE ON THE COBALT GAMMA IRRADIATION OF SODIUM CHLORIDE. EVIDENCE FOR ELECTRICAL INTERACTION BETWEEN DISLOCATIONS AND POINT DEFECTS. R.Truell.
Appl. Phys. (USA), Vol. 32, No. 8, 1601-4 (Aug., 1961).

Ultrasonic attenuation measurements in sodium chloride as a nction of Co^{60} gamma-ray irradiation show no appreciable ependence on temperature in the temperature range from room mperature to liquid nitrogen temperature, hence no appreciable ermal activation energy for the process of immobilizing the slocations. The influence of plastic deformation on the attenuation-radiation behaviour is large; the greater the deformation the ore rapid the attenuation change, at least in the deformation range ~1% deformation. The consequences of these effects are discussed n terms of boundary conditions on possible mechanisms for the bserved effects.

ELECTRICAL PROPERTIES OF SOLIDS

(Superconductivity is included under Low-Temperature Physics)

11248 HEITLER—LONDON APPROACH TO ELECTRICAL CONDUCTIVITY. II. A PROOF OF THE HOPPING MOTION. T.Kurosawa.
J. Phys. Soc. Japan, Vol. 15, No. 7, 1211-16 (July, 1960).

A foundation of the Heitler—London approach to electrical conductivity is given, which was left unproved in the previous paper (Abstr. 8933 of 1961), applying Van Hove's method. The hopping motion of electron is realized under the conditions: large effective mass, strong interaction with the lattice and the presence of a potential fluctuation through the lattice.

11249 ELECTRICAL CONDUCTION PHENOMENA IN ANISOTROPIC MEDIA. I. STRONGLY CONVERGENT SOLUTIONS OF LINEAR OPERATOR EQUATIONS, IN PARTICULAR OF THE BLOCH INTEGRAL EQUATION. D.Langbein.
Z. Phys. (Germany), Vol. 162, No. 5, 542-56 (1961). In German.

Mathematical. A solution by rapidly convergent successive approximations is obtained using the variational procedure equivalent to the integral equation. L.Pincherle

11250 ELECTRICAL PROPERTIES OF CHROMIUM SULFIDES. T.Kamigaichi, K.Masumoto and T.Hihara.
J. Phys. Soc. Japan, Vol. 15, No. 7, 1355 (July, 1960).

Polycrystalline chromium sulphides of composition CrS_x with $1 \leq x \leq 1.20$ were prepared, X-ray photographs revealed that for $x < 1.13$ the compounds have two crystallographic phases, one monoclinic and the other the nickel arsenide type. For $x < 1.13$ a single nickel arsenide type of structure results. The former compositions give rise to p-type semiconductors, the latter to metallic conductors with negative thermo-electric powers. The poor conductivity of the two-phase sulphides is ascribed to the ionic binding in the monoclinic phase, the metallic conduction to the covalent or metallic binding in the nickel arsenide structure. R.Parker

11251 THE CHANGE IN ELECTRICAL RESISTIVITY OF SEVERAL METALS UP TO A PRESSURE OF 200 000 kg/cm^2.
L.F.Vereshchagin, A.A.Semerchan, N.N.Kusin and S.V.Popova.
Dokl. Akad. Nauk SSSR, Vol. 136, No. 2, 320-1 (Jan. 11, 1961). In Russian.

For abstract, see Abstr. 5001 of 1961. [English translation in: Soviet Physics—Doklady (USA), Vol. 6, No. 1, 41-2 (July, 1961)].

11252 INFLUENCE OF PLASTIC STRETCHING ON THE RESISTIVITY OF ALUMINIUM. C.A.Pistorius.
Physica (Netherlands), Vol. 27, No. 2, 149-50 (Feb., 1961).

The increase in resistivity of 99.999% pure Al, and of zone refined Al was measured as a function of strain after stretching at 78°K. The resistance-strain curves are compared with the stress—strain curves and discussed in terms of dislocation density. H.Mykura

11253 CHANGES IN ELECTRICAL RESISTANCE OF VERY THIN BISMUTH FILMS ESPECIALLY DURING THE ADSORPTION OF OXYGEN. W.Ort.
Z. Phys. (Germany), Vol. 163, No. 2, 230-9 (1961). In German.

The bismuth films were deposited by evaporation in a glass ultra high vacuum plant pumped by a 3 l./sec mercury diffusion pump and a small titanium getter ion pump. The evaporation source was carefully degassed and the metal distilled onto the indirectly heated source at a pressure not exceeding 10^{-6} torr to eliminate any pressure rise during the final deposition. The glass substrate had been cleaned in alcohol followed by flame heating to above the softening point of the glass and was provided with silver strip contacts. Bismuth films evaporated at pressures lower than 10^{-8} torr with the glass cooled by immersion in liquid air to 140°K showed a resistance of 10^{10} Ohms. Admission of oxygen up to 10^{-4} torr through a silver diffusion tube caused a drop in resistance to about 10^5 Ohms and to 10^3 Ohms with subsequent heating of the film. A similar film not exposed to oxygen changed its resistance from 10^{10} Ohms to more than 10^{12} Ohms when heated. The conductivity of such granular films was explained by a tunnel effect between neighbouring conducting metallic islands. Adsorption of oxygen caused the corresponding potential barrier to be reduced by up to two diameters of oxygen molecules. Sufficiently thin films evaporated at room temperature also showed such effects in addition to spontaneous fluctuations in resistance attributed to structural changes of the film. W.Steckelmacher

11254 RESISTIVITY AND THERMOELECTRIC POWER OF TRANSITION METALS IN COPPER—GOLD ALLOYS.
M.D.Blue.
Phys. Rev. (USA), Vol. 123, No. 4, 1270-2 (Aug. 15, 1961).

Resistivity and thermoelectric power measurements on CuAu alloys containing dilute amount of Co, Fe, and Mn are discussed. An analysis of these measurements using the thermoelectric power formula of Mott leads to values of the scattering cross-sections of transition elements and their derivatives with respect to energy in good agreement with the values obtained for these elements with Cu or Au as solvent. The results indicate that contributions to resistance due to disorder scattering and impurity scattering are additive in these alloys.

11255 ELECTRICAL RESISTANCE AND ELECTRONIC STRUCTURE OF Cu_3Au. B.R.Coles.
Physica (Netherlands), Vol. 26, No. 2, 143-4 (Feb., 1960).

Points out that in addition to the change of sign of the Hall coefficient when this alloy becomes ordered, the change of electrical resistance is also indicative of the reduction in the freedom of the conduction electrons. The lattice-scattering term increases after ordering, and examination of the elastic constant and specific heat data suggests that Θ, the Debye temperature, also increases. Since the lattice-scattering resistance at high temperatures is proportional to T/Θ^2 for a given configuration of the conduction electrons the observed change must arise from a reduction in the freedom of these electrons. A.E.Kay

11256 LOW-TEMPERATURE RECOVERY OF RESISTIVITY IN ELECTRON-IRRADIATED GOLD.
J.B.Ward and J.W.Kauffman.
Phys. Rev. (USA), Vol. 123, No. 1, 90-6 (July 1, 1961).

The results are described of two electron irradiations of 99.999% purity, 0.008 in. diameter gold wire at 13° and at 10.5°K, respectively, and subsequent isochronal anneals. The anneals were carried out in 1- or 2-degree steps from the lowest temperature up to 65°K, and, in addition, the second set of anneals was extended for

1 hr periods at 125°, 170°, 225°, and 260°K. Each of the anneals produced some recovery. The plot of the slope of the isochronal recovery curves showed peaks and indicated a stage I in the annealing, extending up to 45°K, during which 28.5% of the resistivity increment annealed out. From 45° to 65°K (stage II) no distinct processes were observed. Stage II apparently continues up to 240°K; from 45° to 250°K, 36% of the resistivity increment anneals out; 35.5% remained at this temperature. By assigning a suitable frequency factor K_0 to each process in Stage I, and assuming that the processes are first order (corresponding to recombination of close pairs of vacancies and interstitial), it is possible to calculate the activation energies for each process. For $K_0 = 10^{10}$ to 10^{13} sec^{-1}; these ranged from 0.037 to 0.045 eV for the first peak to 0.11 to 0.13 eV for the fifth. An explanation is suggested for the major differences between the annealing behaviour of gold and copper.

11257 ANOMALOUS CONDUCTIVITY AND LORENZ PARAMETER IN DILUTE SILVER-MANGANESE ALLOYS AT LOW TEMPERATURES. M.S.R.Chari.
Nature (GB), Vol. 189, 824 (March 11, 1961).

Analysis of previous measurements (Abstr. 6023 of 1960) shows that the Lorenz number is independent of magnetic field strength, but passes through a minimum at a temperature (~3°K) which increases with manganese concentration. R.G.Chambers

11258 ON THE SUBJECT OF THE INFLUENCE OF TEMPERATURE ON THE RESISTIVITY OF THIN FILMS OF SILVER. J.Savornin, A.Donnadieu and F.Savornin.
C.R. Acad. Sci. (France), Vol. 252, No. 15, 2195-6 (April 10, 1961). In French.

The work covers silver films evaporated onto glass and silica. In all cases it is found that the heating of the film between 20° and 70°C causes a maximum and then a minimum in resistivity. After the minimum the resistance increases uniformly. A hysteresis effect is also observed. T.C.Toye

11259 ELECTRICAL RESISTIVITY OF CUBIC SODIUM TUNGSTEN BRONZE.
L.D.Ellerbeck, H.R.Shanks, P.H.Sidles and G.C.Danielson.
J. chem. Phys. (USA), Vol. 35, No. 1, 298-302 (July, 1961).

The electrical resistivities of the nonstoichiometric compounds Na_xWO_3 were measured as a function of sodium concentration from x = 0.48 to x = 0.88, and as a function of temperature from T = 4°K to T = 873°K. The minimum in electrical resistivity near x = 0.75, which had been reported by earlier investigators, was absent in single crystals which were selected to be electrically homogeneous. Above room temperature, the electrical conductivity increased approximately linearly with sodium concentration; at liquid-helium temperatures, the electrical conductivity increased approximately as the fourth power of sodium concentration.

11260 ELECTRICAL CONDUCTIVITY AND THERMOELECTRIC EFFECT IN SINGLE-CRYSTAL TiC.
L.E.Hollander, Jr.
J. appl. Phys. (USA), Vol. 32, No. 6, 996-7 (June, 1961).

Single-crystal TiC exhibits a positive temperature coefficient of resistivity in the [100] direction of 200 ± 20 μohm cm. The thermoelectrical power $\Delta V/\Delta T$ referenced against copper at room temperature is 7.8 ± 0.6 μV/deg C and indicates n-type conduction. No hydrostatic piezoresistivity was observed. The predominant cleavage plane for single-crystal TiC is {100}. It can be concluded from P versus T and thermoelectric data that single-crystal TiC has metallic-type conduction, and the predominant charge carriers are electrons.

ELECTRICAL CONDUCTION IN TITANIUM SESQUIOXIDE. See Abstr. 11310

11261 SINGLE-CRYSTAL AND POLYCRYSTAL RESISTIVITY RELATIONSHIPS FOR YTTRIUM.
J.K.Alstad, R.V.Colvin and S.Legvold.
Phys. Rev. (USA), Vol. 123, No. 2, 418-19 (July 15, 1961).

Different proposals for calculating polycrystal resistivities from single-crystal values are applied to yttrium metal. It is shown that a simple average yielding $\rho_{poly} = \frac{1}{3}(2\rho_{\perp} + \rho_{\parallel})$ gives the best fit to experimental data.

11262 ON THE THEORY OF MAGNETORESISTANCE. III. J.Hajdu.
Z. Phys. (Germany), Vol. 163, No. 1, 108-18 (1961). In German.

For Pt II, see Abstr. 1009 of 1961. An extension of the theory to the isotropic two-band model. Some formulae, derived under simplifying assumptions, are given which may be compared with experimental results. L.Pinche

11263 APPLICATION OF THE LONGITUDINAL AND TRANSVERSE MAGNETOCONCENTRATION EFFECT IN THE DETERMINATION OF THE MAGNETORESISTANCE COEFFICIENTS IN ANISOTROPIC CRYSTALS OF CUBIC SYMMETRY. A.A.Grinberg and S.R.Novikov.
Fiz. tverdogo Tela (USSR), Vol. 2, No. 11, 2713-17 (Nov., 1960). In Russian.

A short mathematical paper, showing that the magnetoconcentration effect can be used as a new method of determining experimentally the magnetoresistance coefficients of anisotropic crystals of cubic symmetry. These five coefficients appear in the five terms on the right-hand side of Seitz's equation (Abstr. 8010 of 1950) for the current carried by moving charges in such crystals. Experimental results for n-Ge in weak fields are tabulated alongside those obtained by other authors by other methods. The marked want of agreement should encourage further research. [English translation in: Soviet Physics — Solid State (USA)]. N.D

11264 THE TEMPERATURE DEPENDENCE OF MAGNETORESISTANCE OF MANGANESE FERRITES.
E.V.Talalaeva.
Fiz. tverdogo Tela (USSR), Vol. 3, No. 2, 441-9 (Feb., 1961). In Russian.

The temperature dependence of the longitudinal magnetoresistance and of the magnetization was obtained for manganese ferrite monocrystals. At certain temperatures and in weak magnetic fields the magnetoresistance had a positive component. The relationships found earlier for the magnetoresistance of ferromagnetic metals and alloys in the paramagnetic region are applicable to ferrites. [English translation in: Soviet Physics — Solid State (USA)]. S.Chor

11265 EXTRAORDINARY HALL-EFFECT MEASUREMENTS ON Ni, SOME Ni ALLOYS, AND FERRITES.
J.M.Lavine.
Phys. Rev. (USA), Vol. 123, No. 4, 1273-6 (Aug. 15, 1961).

Extraordinary Hall-effect measurements over a wide range of temperature are reported for 99.9 Ni, 99.4 Ni, 95 Ni, several 80% Ni alloys, Fe_3O_4, and $(NiO)_{0.75}(FeO)_{0.25}(Fe_2O_3)$. The resistivity ρ for all samples over the same temperature range is also reported. At high temperatures, the extraordinary Hall coefficient R_1 for 99.9 Ni is proportional to ρ^2 as predicted by theory. However, the dependence upon ρ is smaller in the 99.9 Ni sample at lower temperatures and in the samples with higher impurity concentration at all temperatures. The 80% Ni samples exhibit positive R_1, while R_1 in the high-concentration Ni samples is negative. R_1 for both ferrites is negative below about 400°C and positive above this temperature. The theoretical work on metals generally indicates that R_1 is proportional to ρ^2 and the constant of proportionality r is weakly temperature dependent and of the order of unity. In the high-concentration Ni samples r is negative, of the order of unity, and exhibits a significant temperature dependence at low temperatures. In the 80% Ni samples, r is positive and of the order of 10^{-2}. At room temperature, r is of the order of 10^{-2} in Fe_3O_4 and of the order of 10^{-6} in $(NiO)_{0.75}(FeO)_{0.25}(Fe_2O_3)$. In both ferrites, r is strongly temperature dependent. The change of sign of r with temperature observed in both ferrites has not been previously observed in metals or alloy

ELECTRONIC EXCHANGE BETWEEN HYDROGEN AND EVAPORATED NICKEL FILMS. See Abstr. 11599

11266 THE NERNST–ETTINGSHAUSEN EFFECT IN P-TYPE GALLIUM ARSENIDE.
O.V.Emel'yanenko, D.N.Nasledov and R.V.Petrov.
Fiz. tverdogo Tela (USSR), Vol. 2, No. 10, 2455-7 (Oct., 1960). In Russian.

The transverse Nernst–Ettingshausen coefficient of p-type GaAs monocrystals was measured as a function of temperature between 200° and 800°K. Maxima of this coefficient occurred at 500°-700°K and were related to hole scattering on acoustic modes of lattice vibrations; at lower temperatures scattering on impurity ions was important. [English translation in: Soviet Physics — Solid State (USA), Vol. 2, No. 10, 2188-9 (April, 1960)]. A.Tybulew

11267 INVESTIGATION OF THE NERNST–ETTINGSHAUSEN THERMOMAGNETIC EFFECTS IN SOLID SOLUTIONS OF THE SYSTEM InSb–AlSb.
Agaev, O.V.Emel'yanenko and D.N.Nasledov.
tverdogo Tela (USSR), Vol. 3, No. 1, 194-7 (June, 1961).
ussian.

Previous work (see Abstr. 15943 and 10328 of 1960) on solid tions of the system InSb–AlSb was extended by measuring the isverse and longitudinal effects in the same substances over a e range of temperatures, and using the results to determine the tering mechanism of the current carriers and also to get more ct data concerning their mobilities. The experimental method described earlier. One set of graphs shows Q^{-1} for pure InSb, –AlSb, 2.5 InSb–7.5 AlSb, and pure AlSb, plotted against peratures up to 800°K. Another set of similar graphs shows for pure InSb, and InSb–AlSb. A fairly entensive discussion of results and conclusions drawn from them is included. [English nslation in: Soviet Physics–Solid State (USA), Vol. 3, No. 1, -3 (July, 1961)]. N.Davy

11268 PECULIARITIES IN THE CONDUCTION OF Ag^+ IONS IN CRYSTALLINE QUARTZ. F.Gross.
ta Phys. Austriaca, Vol. 14, No. 1, 75-85 (1961). In German.

A quartz crystal 8 × 8 × 12 mm with Ag foil electrodes on the l faces, which are perpendicular to the optical axis, conducts preciably by Ag ions when heated. From 200° to 300°C needle- e growths are produced parallel to the axis, but above 500°C mainly ers perpendicular to the axis appear. Apart from these conducting uctures, non-conducting threads occur. Surface metallic growths e also described. Conductivity of Ag^+ perpendicular to the axis is ly 10^{-4} of that parallel to the axis. Some crystals develop an a.c. mponent in the current, of kilocycle range frequency.
S.T.Henderson

11269 TEMPERATURE DEPENDENCE OF CONDUCTIVITY OF LAYERS OF LEAD SULPHIDE AT THE REQUENCY OF 10^{10} c/s. V.G.Erofeichev and L.N.Kurbatov.
. tverdogo Tela (USSR), Vol. 3, No. 2, 595-8 (Feb., 1961).
Russian.

It is shown that at 10^{10} c/s the electrical conductivity of lead lphide is practically independent of temperature in the region om −183°C to +100°C. [English translation in: Soviet Physics – lid State (USA)]. Z.Krasucki

11270 INVESTIGATION OF THE ELECTRICAL CONDUCTIVITY OF RUBIDIUM–BORON GLASSES.
.I.Markin.
iz. tverdogo Tela (USSR), Vol. 3, No. 2, 450-5 (Feb., 1961).
i Russian.

For abstract, see Abstr. 10033 of 1961. [English translation n: Soviet Physics—Solid State (USA), Vol. 3, No. 2, 328-34 :961)].

11271 EFFECT OF HYDROSTATIC PRESSURE ON IONIC CONDUCTIVITY IN DOPED SINGLE CRYSTALS OF ODIUM CHLORIDE, POTASSIUM CHLORIDE, AND RUBIDIUM HLORIDE. C.B.Pierce.
hys. Rev. (USA), Vol. 123, No. 3, 744-54 (Aug. 1, 1961).

The effect of hydrostatic pressure up to 9000 kg/cm² on ionic onductivity in NaCl, KCl, and RbCl single crystals doped with livalent impurities has been studied over the temperature range 00° to 500°C. The conductivity in this temperature range is due lmost entirely to the motion of extrinsic cation vacancies. The ctivation volume ΔV_m for motion of the cation vacancies is .7 ± 0.5 cm³/mole in NaCl doped with $CaCl_2$ and 7.0 ± 0.5 cm³/mole n KCl doped with $SrCl_2$. The results are in fair agreement with alues predicted on the basis of Keyes's empirical expression relating ctivation volume to activation energy and isothermal compressibility. Sample materials were chosen with the view of testing for a correlation between activation energy and shear modulus. The small shear modulus in KCl and RbCl decreases with increasing pressure, while the reverse is true for NaCl. However, the data are not adequate to draw definite conclusions about such a correlation. The conductivity of RbCl doped with $BaCl_2$ increases by an order of magnitude at the phase transition from the NaCl to the CsCl structure. At 300°C, the transition occurs at 6100 kg/cm².

Semiconductors

11272 FERMI LEVEL DEMONSTRATION. R.M.Warner, Jr.
Amer. J. Phys., Vol. 29, No. 8, 529-31 (Aug., 1961).

A simple apparatus demonstrates the dependence of Fermi level upon the temperature and impurity content of a semiconductor. Electrons are represented by ball bearings and states are represented by holes in a plastic sheet. A Fermi probability function template is positioned in energy to accommodate precisely the number of "electrons" originally put into the model, and thus the Fermi level is determined.

11273 ON THE BAND STRUCTURE OF HIGHLY-DOPED SEMICONDUCTORS. G.Winstel and W.Heywang.
Z. Naturforsch. (Germany), Vol. 16a, No. 4, 440-1 (April, 1961).
In German.

The problem of identifying the position of the Fermi level in a tunnel diode is discussed. It is conjectured that impurity states and conduction band states overlap. P.T.Landsberg

11274 EFFECTIVE MASS METHOD IN THE CASE OF NON-QUADRATIC DISPERSION FORMULA. Z.Kopeć.
Acta phys. Polon. (Poland), Vol. 19, No. 3, 295-317 (1960).

The case of a non-parabolic energy band in a semiconductor is analysed and the necessary modification of the usual effective-mass method is deduced. It is found that to describe the motion of single electrons, one must introduce several coefficients, called the differential effective masses, instead of the coefficient m_{ef}. It is shown that in this case the phenomena of electrical transport can be described by the same expressions as in the parabolic case, but with m_{ef} replaced by the "integral effective mass", which is a mean of the differential effective masses. Making use of Kane's dispersion formula, some integral effective masses for n-type InSb are calculated, as well as some scattering coefficients appearing in the Hall and Seebeck effects.

11275 ACOUSTIC-MODE SCATTERING OF HOLES. M.Tiersten.
IBM J.Res. Developm. (USA), Vol. 5, No. 2, 122-31 (April, 1961).

Matrix elements are calculated for acoustic-mode scattering of holes in the valence band structure typified by germanium. Whitfield's generalization of the deformation potential theorem (Abstr. 12785 of 1959; 2373 of 1961) is used to calculate the electron–phonon interaction; the method is extended to include the spin–lattice coupling. A general expression for the electron–phonon interaction matrix element is obtained, and calculations are presented for some special directions in k-space.

11276 INTERACTION OF CONDUCTION ELECTRONS WITH ACOUSTIC WAVES IN MANY-VALLEY SEMICONDUCTORS. N.Mikoshiba.
J. Phys. Soc. Japan, Vol. 15, No. 7, 1189-99 (July, 1960).

A semi-classical theory is given for explaining the characteristics of the interaction in semiconductors such as n-Ge. In general, the ultrasonic absorption coefficient can be written as

$$\Lambda = \Lambda_P + \Lambda_K,$$

where Λ_P is due to the change of the deformation potential energy of electrons caused by net intervalley transitions, Λ_K due to the change of the kinetic energy caused by intravalley transitions. The acousto-electromotive force can be also written as

$$F = F_P + F_K.$$

In the low frequency range the dominant terms are Λ_P and F_P, but Λ_K and F_K predominate in sufficiently high frequency range. For longitudinal waves propagating in the ⟨110⟩ direction and transverse waves propagating in the ⟨100⟩ direction and polarized in the ⟨010⟩ direction, F is identical with the formula of Weinreich–Sanders–White (Abstr. 6969 of 1959) in the low frequency range. But in contrast to their formula, F does not decrease in the high frequency range owing to the increase of F_K and has the same order of magnitude as that for longitudinal waves in simple semiconductors. In special cases such as for longitudinal waves propagating in the ⟨100⟩ direction and transverse waves propagating in the ⟨110⟩ direction and polarized in the ⟨1$\bar{1}$0⟩ direction, $\Lambda_P = F_P = 0$ and then the interaction becomes essentially identical with that in simple semiconductors.

11277 NEGATIVE RESISTANCE AND HOT ELECTRONS. I.Adawi.
J. appl. Phys. (USA), Vol. 32, No. 6, 1101-11 (June, 1961).

Current–voltage characteristics of hot electrons are analysed for negative resistance regions. Electrons in a homogeneous semiconductor are assumed to interact only with acoustical phonons and charged centres of heavy mass. These charged centres could be ionized impurities or heavy holes with a negligible contribution to the current. A distribution function which ignores electron–electron collision almost certainly does not lead to negative resistance. A postulated Maxwellian distribution may lead to a current discontinuity, but does not lead to a stable region of negative resistance, contrary to previous conclusions. For any physical distribution it is shown that the average electron energy increases monotonically with field strength. These results also apply to situations in gaseous discharge where hot electrons are scattered by neutral molecules and ions.

11278 NOTE ON THE FIELD DEPENDENCE OF THE MOBILITY IN SEMICONDUCTORS.
M.Hattori and H.Sato.
J. Phys. Soc. Japan, Vol. 15, No. 7, 1237-42 (July, 1960).

By assuming that the mobility μ can be expanded in powers of the field strength F as $\mu = \mu_0(1 - \nu F^2)$, ν is calculated for non-polar and polar semiconductors. The electron–electron interactions are neglected completely and the Boltzmann equation is solved by means of the variation method. It is shown that ν calculated in this way differs significantly from that calculated in a previous paper and in Stratton's (1958) particularly at low temperatures. The electric field dependence of the Hall coefficient is also estimated.

11279 ALTERNATIVE APPROACH TO THE SOLUTION OF ADDED CARRIER TRANSPORT PROBLEMS IN SEMICONDUCTORS. J.P.McKelvey, R.L.Longini and T.P.Brody.
Phys. Rev. (USA), Vol. 123, No. 1, 51-7 (July 1, 1961).

A novel method of solving added carrier transport problems in semiconductors is presented. The usual procedure in treating problems of this type is to derive a continuity equation for charge carriers on the basis of carrier conservation, allowing for generation and recombination, and to solve this equation under appropriate boundary conditions. The resulting fluxes or currents are obtained from diffusion and drift current equations, which involve the concentrations and concentration gradients. In the formulation presented here, equations embodying conservation of flux (again with due allowance for generation and recombination) which incorporate the proper boundary conditions from the outset are solved in the steady-state one-dimensional case to yield a Green's function for the desired carrier fluxes directly. The method is more general than the commonly used continuity equation formulation in that the physical dimensions of the system and the diffusion lengths are not restricted to be large compared to the mean free path; in particular it is unnecessary to assume Fick's law for diffusion processes. Otherwise the method is equivalent to the continuity equation analysis. An example involving carrier generation in a plane region bounded on one side by a surface of arbitrary reflection coefficient (or recombination velocity) and on the other by a collecting p–n junction is worked out. The results are shown to reduce to those obtained via the continuity equation in the appropriate limiting case.

11280 CURRENT-CARRIER TRANSPORT WITH SPACE CHARGE IN SEMICONDUCTORS. W.van Roosbroeck.
Phys. Rev. (USA), Vol. 123, No. 2, 474-90 (July 15, 1961).

Differential equations are given for a general formulation of current-carrier transport that includes space charge. Arbitrary dependences of diffusivities and magnitudes of drift velocities on electrostatic field are considered, and extension is made for applied magnetic field. Though excess electron and hole concentrations are not equal, the small-signal recombination rate depends on a single lifetime, the "diffusion-length lifetime", τ_0. The formulation is applied to one-dimensional drift with recombination for an injected pulse of electron-hole pairs. The exact electron and hole distributions are obtained in closed form for the linear small-signal case. The condition for linearity is given; it is usually the same as that for substantially unperturbed applied field, E_0. There are two principal types of solution, essentially according to whether τ_0 is larger or smaller than the dielectric relaxation time, τ_d. For $\tau_0 > \tau_d$, the electron and hole distributions in not too strongly extrinsic material are ultimately similar Gaussian distributions displaced by the "polarization distance", x_P, the distance electrons and holes drift apart in time $(\tau_d^{-1} - \tau_0^{-1})^{-1}$. These distributions drift at a velocity that differs from the ambipolar velocity by an amount which, besides being small for small τ_d/τ_0, vanishes for equal mobilities. The spread, exhibiting an apparent diffusion. A "pseudodiffusivity", D_V is defined. For $\tau_0 \gg \tau_d$ and constant mobilities, D_V is proportional to $\tau_d E_0^2/\sigma_0^2$, with σ_0 the conductivity. The ambipolar diffusivity and D_V are additive. They are equal in intrinsic material for E equal to kT/e divided by the Debye length $(kT\epsilon/8\pi n_i e^2)^{1/2}$, or 10 for silicon at 300°K. An extension to a non-linear case involving high-level injections is given; concentration-dependent D_V and velocity function are defined. For sufficiently strongly extrinsic material and $\tau_0 > \tau_d$, the minority carriers drift in a delta pulse that leads the majority carriers distributed in an exponential tail characteristic length x_P, which may be quite large. For non-constant mobilities and $\tau_0 > \tau_d$, ambipolar velocity in the majority-carrier "reverse" direction may occur. For $\tau_d > \tau_0$, the other principal of solution gives distributions that in general (and for constant mobilities) drift in the reverse direction. Involving also regions of carrier depletion, and thus generation as well as recombination, these distributions may persist for times long compared with τ_0, being attenuated then with time constant τ_d.

11281 MECHANISM OF IMPURITY CONDUCTION IN SEMICONDUCTORS. J.Mycielski.
Phys. Rev. (USA), Vol. 123, No. 1, 99-103 (July 1, 1961).

A new possible mechanism of impurity conduction at low temperatures is proposed. The conductivity is thought of as due to the carrier jumps over the Coulomb potential wall from the occupied impurity centres to the empty ones. The activation energy of conductivity and, in the case of strong carrier-phonon interaction, the conductivity itself is calculated and compared with Fritzsche's experimental data (Abstr. 7954 of 1955; 13595 of 1960) for the so-called "ϵ_2 anomaly" in p- and n-type germanium.

11282 CONTRIBUTION OF LATTICE SCATTERING BETWEEN NONEQUIVALENT VALLEYS TO FREE-CARRIER INFRARED ABSORPTION IN SEMICONDUCTORS.
H.Risken and H.J.G.Meyer.
Phys. Rev. (USA), Vol. 123, No. 2, 416-18 (July 15, 1961).

In a multivalley band-structure like that of the conduction b of germanium, a contribution to the absorption of infrared radia by free carriers is made by a scattering process which does not play a role in normal transport processes but which may be of importance for hot-electron phenomena; this is the scattering between non-equivalent valleys of the conduction band. The absorp induced by this extra scattering process results in a transfer of electrons from the ⟨111⟩ valleys to the ⟨100⟩ valleys or the [00 valley. A quantum-mechanical calculation was made of the part absorption constant μ_i^* due to this scattering on the basis of a deformation-potential type theory. The final formula obtained f μ_i^* is similar to that derived previously for the partial absorpti constant μ^{opt} due to optical intravalley scattering. The physica significance of some limiting forms of μ_i^* at low temperatures discussed.

11283 ELECTRON–ELECTRON INTERACTION IN HOT ELECTRON PROBLEMS. J.Yamashita.
Progr. theor. Phys. (Japan), Vol. 24, No. 2, 357-69 (Aug., 1960)

Abstr. 3441 of 1959. The behaviour of warm and hot electr in n-type germanium at 77°K are investigated theoretically. The following assumptions are adopted: (1) electrons are not degene (2) the shape of the energy surface is spherically symmetric; (3) electrons are scattered by acoustic and optical modes of vibrations, and by ionized impurity centres; (4) the electron–electron interaction is taken into account by the Fokker–Planck approximation. The results are compared with Gunn's experime (Abstr. 6962 of 1959). It is found that the Maxwellian distributio function with the electron temperature does not give a good agre ment with experiment when the impurity density is low. On the other hand, the electron–electron interaction works decisively i reducing the electron distribution to the Maxwellian form when t impurity density is high. The critical density seems to lie near 10^{18} cm^{-3} at 77°K.

11284 THEORY OF ATOMIC SEMICONDUCTORS. I. DERIVATION OF THE HAMILTONIAN OF AN ATO SEMICONDUCTOR IN A POLAR CRYSTAL MODEL.
A.H.Samoilovich and V.M.Kondratenko.
Ukrayin. fiz. Zh. (USSR), Vol. 3, No. 1, 41-52 (1958). In Ukrai with summary (1½ pp.) in Russian.

The Hamiltonian is derived on the basis of a Vonsovskii po model allowing for excitons. The third-order terms, which giv the probabilities of different transitions between elementary excitations are taken into consideration. The Hamiltonian is converted into a quasi-momentum space which admits the intr

of the quasiparticle operators. The Hamiltonian in the momentum space is written in a form which allows the physical meaning of its terms to be readily apparent. This form, in particular, leads to the conclusion that the exciton annihilated in ital may give rise to pairs and holes but it may also be lated without producing the latter, the exciton energy being. erred to the pairs and holes already existing in the crystal.

285 GALVANOMAGNETIC EFFECTS IN SEMICONDUCTORS AT HIGH ELECTRIC FIELDS. E.M.Conwell.
Rev. (USA), Vol. 123, No. 2, 454-63 (July 15, 1961).
treatment of magnetoconductivity is developed for high elec- elds and general energy-band structure using a partial solu- f the Boltzmann equation in a form similar to that set up by ıre for low electric fields. The present treatment is valid the scattering processes are such that the distribution function s but a small amount over an entire constant-energy surface, the case of the many-valley band structure, over the part of a ant-energy surface within each valley. In the latter case, ent distributions functions must be used for the different ys. The elements of the magnetoconductivity matrix that results xpressed in terms of carrier concentration, total or within each y, and averages over the carriers of a quantity involving the entum relaxation time and the S tensor defined by McClure. tensor, which depends on the shape of the constant-energy sur- and on the magnetic-field strength, is evaluated for the idual valleys in a non-degenerate many-valley semiconductor. magnetoconductivity matrix is then in a form convenient for cal- ion of conductivity and galvomagnetic effects for either low or electric fields. It is used to obtain expressions for anisotropy ge and Hall coefficient in high electric fields involving the num- of carriers in each valley, orientation of the valleys, and valley ages over quantities involving relaxation time and energy.

1286 [INTRINSIC] SEMICONDUCTOR MAGNETORESISTANCE EFFECT IN THE CASE OF WEAK FIELDS.
.Tsymburs'ka.
ayin. fiz Zh. (USSR), Vol. 4, No. 2, 177-82 (1959). In Ukrainian.
This case ($h\omega^*_0/kT \ll 1$) is considered on the basis of a polar crystal iel. The Hamiltonian of an atomic crystal placed in crossed ds, $\vec{H} \perp \vec{F}$, is written in a second quantization representation by ıns of Bose-Vonsovskii operators describing crystal excitations .rs and holes). The ground Hamiltonian includes the interaction ween the system of elementary excitations and the lattice thermal rations at the first approximation. The energy spectrum of the ited system is computed. The operator for perturbation is ined as the operator for the energy of interaction between the tem of elementary excitations and the thermal vibrations at the ond approximation. An expression for the current density in the d direction F is obtained by the method of stationary states. The istivity is computed (for the case of weak fields $h\omega^*_0/kT \ll 1$). A ıdratic dependence is obtained for the magnetoresistance.

11287 HALL MOBILITY OF DEGENERATE SEMICONDUCTORS. D.B.Agarwal.
Phys. (Germany), Vol. 163, No. 2, 207-10 (1961).
The dependence of Hall mobility of carriers on impurity ntent is investigated theoretically for degenerate semiconductors, ding account of scattering by lattice vibrations as well as by ıized impurities. The scattering due to optical modes of lattice ɔrations is neglected, for the sake of simplicity of calculation. ıis omission is not serious at temperatures at which the impurity attering is important.

11288 SOME THEORETICAL CONSIDERATIONS ON THE LONGITUDINAL MAGNETIC FIELD INDUCED SCILLATIONS IN SEMICONDUCTORS (THE OSCILLISTOR) AND A ENTATIVE EXPLANATION. A.C.Prior.
roc. Phys. Soc. (GB), Vol. 77, Pt 6, 1121-4 (June, 1961).
The conditions under which oscillations were observed are ıown to be such that a system of transient circulating currents can ise. These currents will tend to increase the carrier concentration one surface of the specimen, and thus modify the surface recom- ination. Oscillations of a relaxation type could plausibly result. he model suggests variations of frequency and amplitude with agnetic field intensity and direction, and with electric field and mperature similar to that reported, and could account for the ccurrence of incoherent oscillations with an accurately aligned agnetic field.

11289 MEASUREMENT OF DIFFUSIVITY, LIFETIME AND SURFACE RECOMBINATION VELOCITY IN SEMICONDUCTORS BY THE FLYING SPOT METHOD.
J.Gyulai and J.Lang.
Acta. phys. chem. Szeged. (Hungary), Vol. 6, No. 1-4, 23-32 (1960).
A detailed discussion of the continuity equation for charge carriers with surface recombination is given for the case of generation by a flying spot. The solution is in a form concenient for experimental studies, and makes it possible to determine simultaneously bulk lifetime, ambipolar diffusivity and surface recombination velocity. The reliability of the method is proved by measurements carried out on germanium. F.Ansbacher

11290 APPARATUS FOR THE MEASUREMENT OF GALVANOMAGNETIC EFFECTS IN HIGH-RESISTANCE SEMICONDUCTORS. G.Fischer, D.Greig and E.Mooser.
Rev. sci. Instrum. (USA), Vol. 32, No. 7, 842-6 (July, 1961).
An apparatus for the measurement of galvanomagnetic effects in high-resistance semiconductors is described. The apparatus allows the resistivities of samples to be measured whose resistances fall within the range 10^{-1} to 10^{12} Ω. The Hall coefficients of these samples can also be determined with the apparatus as long as the charge-carrier mobilities of the samples exceed 1 $cm^2 V^{-1} sec^{-1}$. A discussion is given of the fundamental limitations of Hall coefficient measuring equipment.

11291 MICROWAVE MEASUREMENT OF MOBILITY: ANALYSIS OF APPARATUS.
S.H.Liu, Y.Nishina and R.H.Good, Jr.
Rev. sci. Instrum. (USA), Vol. 32, No. 7, 784-9 (July, 1961).
The microwave mobility in a semiconductor can be obtained by mounting a sample in a bimodal cavity with an applied static magnetic field and then measuring the power transfer which is produced by the Faraday rotation in the sample. This paper gives an analysis of the effect based on the field distributions in the cavity and the wave propagation in the sample. The dependence of the power transfer on the static applied magnetic field, on the mobility and conductivity of the sample, and on an effective sample size is obtained.

11292 MICROWAVE MEASUREMENT OF HALL MOBILITY: EXPERIMENTAL METHOD.
Y.Nishina and G.C.Danielson.
Rev. sci. Instrum. (USA), Vol. 32, No. 7, 790-3 (July, 1961).
Hall mobilities of germanium single crystals were measured at a frequency of 9000 Mc/s over the temperature range 30°-300°K. A rectangular sample occupied the central part of a wall of a rectangular cavity, which was doubly degenerate in the TE_{101} mode and in the TE_{011} mode at a single resonance microwave frequency. The external magnetic field and the microwave field associated with one of the two modes gave rise to the other mode of oscillation. The theoretical analysis by Liu, Nishina and Good (see preceding abstract) was verified by measurements on an n-type sample having a room temperature resistivity of 0.40 ohm cm. The measured Hall mobility at microwave frequencies (with a size correction) was compared with the d.c. Hall mobility between 30°K and 300°K. The agreement was excellent.

Semiconducting Materials

EPITAXIALLY GROWN SEMICONDUCTING FILMS. INTERFERENCE METHOD FOR MEASURING THICKNESS.
See Abstr. 11591

11293 LONGITUDINAL MAGNETORESISTANCE IN N-TYPE GERMANIUM: EXPERIMENTAL.
W.F.Love and W.F.Wei.
Phys. Rev. (USA), Vol. 123, No. 1, 67-73 (July 1, 1961).
Measurements of the longitudinal magnetoresistance of single crystals of pure and doped n-type germanium oriented in the ⟨100⟩, ⟨110⟩, and ⟨111⟩ directions were made in magnetic fields up to 300 kG over the temperature interval 20°-300°K. The magnetoresistance ratio $\rho(H)/\rho(0)$ was found to vary linearly with magnetic field strength in the quantum limit. Magnetoresistance ratios less than one were observed and explained on the basis on the many-valley structure of the conduction band. The saturation of magnetoresistance predicted by classical transport theory was observed at the higher end of the temperature range and used to demonstrate a temperature variation of the anisotropy parameter K.

11294 LONGITUDINAL MAGNETORESISTANCE IN N-TYPE GERMANIUM: THEORETICAL.
S.C.Miller and M.A.Omar.
Phys. Rev. (USA), Vol. 123, No. 1, 74-80 (July 1, 1961).

The longitudinal magnetoresistance of n-type germanium is calculated for high magnetic fields where Landau levels are important. The scattering mechanisms considered are acoustic and ionized impurity scattering. Comparison is made with experiment for acoustic scattering and is found to be satisfactory for sufficiently high fields.

11295 INFLUENCE OF WET AND DRY AMBIENTS ON FAST SURFACE STATES OF GERMANIUM.
Y.Margoninski and H.E.Farnsworth.
Phys. Rev. (USA), Vol. 123, No. 1, 135-40 (July 1, 1961).

Simultaneous measurements of surface recombination velocity and added trapped charge density in the fast states as a function of surface potential were carried out on an n-type specimen which was subjected to the following gaseous ambient cycles: (a) room air-vacuum, (b) dry air-vacuum, (c) dry oxygen-vacuum, (d) dry nitrogen-vacuum, (e) wet nitrogen-vacuum, and (f) wet oxygen-vacuum. The most important results of these measurements were: (1) Dry nitrogen had no influence whatsoever on any of the surface-state parameters, (2) dry oxygen affected only the density of states and the unperturbed surface potential, and (3) wet nitrogen and wet oxygen had almost the same and most pronounced effect on the fast surface states.

11296 CONDUCTIVITY OF A Ge SURFACE.
V.I.Lyashenko and T.N.Sÿtenko.
Ukrayin. fiz. Zh. (USSR), Vol. 3, No. 1, 64-70 (1958). In Ukrainian, with summary (1½ pp.) in Russian.

The Hall effect, with a change in the surface charge by the outer electrical field, was measured. Effective mobility increases or decreases depending upon the field direction. The magneto-resistance of the Ge specimens was measured in two positions: along the magnetic field $\Delta\rho_\perp$ and across it $\Delta\rho_\parallel$. It appears that $\Delta\rho_\perp > \Delta\rho_\parallel$. The explanation of the experiments is based on an assumption of the existence of surface band conductivity.

11297 GERMANIUM FILMS ON GERMANIUM OBTAINED BY THERMAL EVAPORATION IN VACUUM.
O.Weinreich, G.Dermit and C.Tufts.
J. appl. Phys. (USA), Vol. 32, No. 6, 1170-1 (June, 1961).

The preparation of crystalline films of germanium on germanium substrates by thermal evaporation in vacuum and measurement of resulting junctions between films and substrate are described. Electron diffraction patterns and microphotographs of the film, substrate and junction are reproduced. J.B.Birks

11298 INVESTIGATION OF RECOMBINATION PROCESSES IN GERMANIUM DOPED WITH SOME IMPURITIES. I. PURE AND DOPED WITH Sb OR Ga.
A.D.Byelyayev, K.D.Hlinchuk and O.H.Miselyuk.
Ukrayin. fiz. Zh. (USSR), Vol. 3, No. 5, 624-31 (1958). In Ukrainian, with summary (1 p.) in Russian.

Investigations were conducted on the temperature dependence of the lifetime of injected carriers. Samples of 40-60 ohm cm Ge were used and the Sb and Ge concentrations were from about 5×10^{13} to about 5×10^{17} cm^{-3}. Recombination takes place through localized levels with an activation energy of 0.08-0.16 eV. The inference is drawn that these levels may be identified with the structural defects arising during crystal growth.

11299 INVESTIGATION OF THE RECOMBINATION OF CHARGE CARRIERS IN GERMANIUM DOPED WITH SOME IMPURITIES. II. Fe, Co, Ni AND THERMOACCEPTORS.
K.D.Hlinchuk, O.H. Miselyuk and N.M.Fortunatova.
Ukrayin. fiz. Zh. (USSR), Vol. 4, No. 2, 207-18 (1959). In Ukrainian.

Measurements were carried out on the lifetime τ of injected carriers and its temperature dependence in n- and p-type germanium doped with Fe, Co, Ni and with thermoacceptors. The introduction of these impurities drastically decreases τ for pure germanium. The Fe, Co and Ni impurities may precipitate out on annealing at a temperature of 450-600° C. Recombination in annealed samples occurs through energy levels with an activation energy of 0.06-0.12 eV, which coincides with the value obtained in samples of "pure" germanium or those containing Sb or Ga impurities.

SURFACE KINETICS AND PHYSICS INVESTIGATION OF THE REACTION BETWEEN SINGLE-CRYSTAL GERMANIUM AND IODINE. See Abstr.11612

11300 THEORY OF MICROPLASMA INSTABILITY IN SILICON. R.J.McIntyre.
J. appl. Phys. (USA), Vol. 32, No. 6, 983-95 (June, 1961).

A statistical theory is presented to explain microplasma instability at the onset of avalanche in reverse-biased silicon linearly graded and step junctions. An expression is derived whi related the turnoff probability of the microplasma to the differe resistance of the diode in its conducting state and to other physi measurable diode parameters. Measurements of the turnoff probability as a function of the pulse current are presented for several diodes and are shown to agree well with the derived theo To explain the turnon probability, three expressions, each involv slightly different approximations, are derived for the probability that a carrier entering the breakdown region will initiate an avalanche. In each case, this probability is found to be proportio to the excess of the applied voltage over a uniquely definable sustaining voltage V_S, in poor agreement with experiment. The various mechanisms which determine the diode's differential impedance in the conducting state are discussed and approximat expressions for the contributions of each mechanism to the diffe ential impedance are derived. Multilevel pulses, previously inte preted as indicating more than one conducting state for a micro plasma, are explained in terms of parallel breakdowns of more than one microplasma.

11301 STUDY OF Li–O INTERACTION IN Si BY ION DRIF
E.M.Pell.
J. appl. Phys. (USA), Vol. 32, No. 6, 1048-51 (June, 1961).

Ion drift in a reverse-biased n–p junction was used to meas effective drift mobilities of Li^+ between 20°-125°C in Si samples containing oxygen concentrations up to 1.3×10^{18} atoms/cm^3. Previous experiments have indicated that under such conditions, Li^+ and oxygen will combine to form a complex for the form LiO The ratio of the effective drift mobility of Li^+ in such samples t the known drift mobility of free Li^+, when measured as a functio of temperature, can be used to determine the dissociation consta of LiO^+. Thus, at an oxygen concentration of 1.3×10^{18} atoms/c diffusion constant at 50°C is reduced from 1.7×10^{-13} cm^2/sec t $(7.6 \pm 2.2) \times 10^{-16}$ cm^2/sec by the Li^+–O interaction. From this and measurements at other temperatures, the dissociation consta of LiO^+ can be calculated, yielding $C = (5.8 \times 10^{15}) \pm 30\%$ at 50°C with an activation energy of 0.42 ± 0.03 eV, or more generally, $C = (0.5\text{-}8.5) \times 10^{22} \exp-[(0.42 \pm 0.03)e/kT]$. At high concentrati the effective drift mobility is found to be inversely proportional t the oxygen concentration, in accordance with the model. The use this technique for the measurement of oxygen concentrations belo 10^{17} atoms/cm^3 is discussed, and some examples of such measur ments are given.

11302 RECOMBINATION KINETICS FOR THERMALLY DISSOCIATED Li–B ION PAIRS IN Si.
E.M.Pell and F.S.Ham.
J. appl. Phys. (USA), Vol. 32, No. 6, 1052-63 (June, 1961).

The kinetics of a diffusion-limited pairing reaction between oppositely charged impurity ions in a solid were studied by obser the capture of mobile Li^+ ions by B^- ions in Si. The kinetics wer determined by measuring resistivity versus time after the metho of Reiss, Fuller and Morin (Abstr. 6635 of 1958) as pairing proce the resistivity decreases because of the disappearance of the charged impurity scattering associated with unpaired ions. Meas ments were made between 2° and 35°C. The observed kinetics ar not of first order, and are best described by a model in which pai is largely a random process with little correlation between particular Li^+ and B^- ions. Diffusion constants of Li^+ calculated from the kinetics are in accord with previous ion-drift results.

11303 SURFACE POTENTIAL OF SILICON.
C.T.Raymo, C.W.Brands and B.Schwartz.
J. appl. Phys. (USA), Vol. 32, No. 6, 1165-6 (June, 1961).

It is shown that the surface potential of silicon may be deter mined by the d.c. field effect technique, provided the temperature of the specimen is accurately controlled, and high electric fields are used. P.A.Wall

11304 VISIBLE LIGHT EMISSION AND MICROPLASMA PHENOMENA IN SILICON P–N JUNCTION. II. CLASSIFICATION OF WEAK SPOTS IN DIFFUSED P–N JUNCTIONS. M.Kikuchi.
J. Phys. Soc. Japan, Vol. 15, No. 10, 1822-31 (Oct., 1960).

For Pt I see Abstr. 8949 of 1961. In the course of study on the visible light emission and microplasma phenomena in diffuse silicon p–n junctions, it was discovered that there exist several

of weak spots in the junction. They can be roughly classified wo groups, one of them includes tiny weak spots which reveal oplasma current pulses at certain characteristic bias voltages, he other includes tiny spots which contribute a "soft" com- nt to the reverse current without being accompanied with oplasma pulses. The latter type of spots could be produced ratching the surface of the junction with a tungsten needle, eas the former could not be produced by the same operation. al diffused junctions there are distributed the above mentioned s of point defects. Typical experimental results are given, and correlation between those weak spots and the current–voltage acteristics is discussed.

11305 ELECTRICAL AND GALVANOMAGNETIC PROPERTIES OF CRYSTALLINE P-TYPE INDIUM ANTIMONIDE AT TEMPERATURES.
' Chzhi-Chao [Lien Chih-Ch'ao] and D.N.Nasledov.
tverdogo Tela (USSR), Vol. 3, No. 5, 1458-64 (May, 1961).
ussian.

The properties of p-type indium antimonide with impurity centrations of 10^{13}-10^{15} cm^{-3} were measured in the temperature ge from 78°K to liquid He temperature. The acceptor activation rgy was found to be $7-9 \times 10^{-3}$ eV. Heat treatment was shown ave a pronounced effect on these properties, and the activation rgy of thermally produced acceptors was found to be $1.4-1.6 - 1.6 \times 10^{-2}$ eV. The liquid He results were interpreted in terms onduction in two bands. Some of the observations are not in eement with the ideas of impurity band conduction. [English nslation in: Soviet Physics – Solid State (USA)]. K.N.R.Taylor

11306 PINCH EFFECT IN INDIUM ANTIMONIDE.
A.G.Chynoweth and A.A.Murray.
ys. Rev. (USA), Vol. 123, No. 2, 515-20 (July 15, 1961).

At the International Semiconductor Conference held at chester, in 1958, Glicksman and Steele (Abstr. 6974 of 1957) pre- nted some data on the effects of an external, longitudinal, magnetic ld on the current–voltage characteristic of single crystals of lium antimonide at high electric fields. At the time, the effects re unexplained, but, subsequently, the same authors ascribed em to self-pinching of the current in the crystal (Abstr. 1672 of 60). The work described in this paper corroborates and extends e experimental results of Glicksman and Steele. The critical rrent at which pinching occurs in indium antimonide was measured three independent methods: (a) by noting the current at which e pinched current–voltage characteristic deviates from the un- nched characteristic that is obtained in the presence of a longitud- al magnetic field H, using crystals of sufficiently high resistance r the avalanche breakdown current to be considerable, before nching sets in, as the electric field is increased; (b) by noting the rrent at which the magnetoresistance, as a function of H, shows a ange in its behaviour; and (c) from a study of the critical current s a function of H. The three methods lead to a value for the ritical pinching current of 4-5 A. This current is the same for oth single-crystal and polycrystalline samples, and is insensitive small changes in the donor concentration or cross-sectional area f the crystal. The value of the critical current leads to a mean arrier temperature of 0.04 eV in avalanche breakdown. An irregu- ar form of noise is observed when the crystal is operated in the ransition region between the pinched and unpinched conditions, and t is thought that this noise is caused by pinching–unpinching instab- lities.

RECOVERY OF ELECTRON RADIATION DAMAGE IN N-TYPE InSb. See Abstr. 11244

11307 ELECTRICAL PROPERTIES OF ORGANIC SOLIDS. IV. CHARGE CARRIER DIFFUSIVITY IN METAL-FREE PHTHALOCYANINE. D.R.Kearns and M.Calvin.
J. chem. Phys. (USA), Vol. 34, No. 6, 2022-5 (June, 1961).

For previous work see Abstr. 6144-5 of 1960. The pulsed light technique was applied to determine the charge carrier mobility in microcrystalline or amorphous, metal-free phthalocyanine layers. This appears to be of the order of 10^{-3} to 10^{-2} cm^2 sec^{-1} V^{-1}, and the positive holes are the majority carriers. The low values are attributed to the physical state of the layer.

11308 MEASUREMENT OF MINORITY CARRIER LIFETIME IN SiC BY A NOVEL ELECTROLUMINESCENT METHOD. G.G.Harman and R.L.Raybold.
J. appl. Phys. (USA), Vol. 32, No. 6, 1168-9 (June, 1961).

A new method of measuring minority carrier lifetime in large energy gap semiconductors by observing the decrease in the intensity of the minority carrier recombination electroluminescence when the reciprocal frequency of the applied voltage becomes comparable to the lifetime. This method has the advantages of simple apparatus and specimen requirements, and is particularly suitable for measuring short lifetimes, ($< 10^{-7}$ sec), such as are found in SiC.
P.A.Walker

11309 SPACE CHARGE LIMITED CURRENT FLOW AND DEEP TRAPPING IN SELENIUM.
H.P.D.Lanyon and W.E.Spear.
Proc. Phys. Soc. (GB), Vol. 77, Pt 6, 1157-65 (June, 1961).

Current–voltage characteristics of evaporated specimens of vitreous selenium were studied. They show an ohmic part at low applied voltages and, with increasing hole injection, a V^2 region which precedes the trap-filled limit as predicted by Lampert's theory. Ohmic contacts of tellurium or platinum were formed on newly prepared specimens by the prolonged application of a moderately high electric field, but this was not found possible with a low work-function electrode such as magnesium. The detailed analysis of the results from formed specimens between 2 and 31 μ thick indicates the existence of a volume distribution of hole traps of density 9×10^{13} cm^{-3}, 0.79 eV above the valence band. These values agree with independent results from measurements of the transient photoconductivity after saturation of the centres with strong illumination. At room temperature the average trapping time is 50 seconds leading to a capture cross-section of 8×10^{-18} cm^2. The presence of the 0.79 eV level offers some explanation for the pronounced difference between the absorption and photoconductive edges in vitreous selenium. It is concluded that the level lies near the upper edge of a comparatively dense distribution of states extending towards the valence band.

11310 ELECTRICAL CONDUCTION IN p-TYPE TITANIUM SESQUIOXIDE. J.Yahia and H.P.R.Frederikse.
Phys. Rev. (USA), Vol. 123, No. 4, 1257-61 (Aug. 15, 1961).

The Hall effect, thermoelectric power, and electrical conductivity were measured as a function of temperature in crystals of p-type titanium sesquioxide. A transition is observed at about 450°K. Below this temperature the crystals behave like semiconductors, while above it the conductivity is apparently metallic. The behaviour below 450°K is in line with antiferromagnetic ordering. The effective mass of the holes is found to be about $5m_0$ and the average Hall mobility 5 cm^2 V^{-1} sec^{-1} at room temperature It is claimed that these values, combined with the fact that the Hall effect is measurable, support the assumption of conduction in a narrow 3d band.

11311 ON THE AGREEMENT BETWEEN THE ELECTRICAL DARK CONDUCTIVITY AND THE GREEN LUMINESCENCE OF ZnO. E.Mollwo.
Z. Phys. (Germany), Vol. 162, No. 5, 557-61 (1961). In German.

The interrelation of dark conductivity and luminescence is examined in crystals with different impurity additions. Luminescence shows a maximum efficiency in crystals of about 5×10^{-2} Ω^{-1} cm^{-1} conductivity. G.F.J.Garlick

Semiconductor Devices

11312 A CURIOUS CHARACTERISTIC OF P–N–P–N JUNCTIONS. T.Kurata and K.Komatsubara.
J. Phys. Soc. Japan, Vol. 15, No. 2, 362-3 (Feb., 1960).

In some silicon devices an anomalous valley region was observed at 20°C in the switching characteristic at low forward currents, i.e. about 30 μA at 35 to 40 V. The characteristics for higher currents were normal in form. C.A.Hogarth

11313 TEMPERATURE DEPENDENCE OF THE TUNNEL CURRENT IN P-N JUNCTIONS.
B.M.Vul, A.P.Shotov and S.P.Grishechkina.
Fiz. tverdogo Tela (USSR), Vol. 3, No. 2, 667-9 (Feb., 1961).
In Russian.

For abstract, see Abstr. 10053 of 1961. [English translation in: Soviet Physics–Solid State (USA), Vol. 3, No. 2, 489-90 (1961)].

11314 IMPURITY BAND CONDUCTION AND THE PROBLEM OF EXCESS CURRENT IN TUNNEL DIODES. T.P.Brody.
J. appl. Phys. (USA), Vol. 32, No. 4, 746-7 (April, 1961).

An attempt is made to synthesize the band structure in degenerate Ge on the basis of impurity band theories, and computations are made of the tunnel currents. The model implies that a tail of

low-energy states extends into the forbidden gap, and the Fermi level lies near or below the bottom of the conduction band. Experiment confirms some of the predictions. C.Hilsum

11315 TEMPERATURE DEPENDENCE OF TUNNEL DIODE CHARACTERISTICS. Y.Furukawa.
J. Phys. Soc. Japan, Vol. 15, No. 6, 1130 (June, 1960).

The temperature dependence of maximum junction current for Sb-doped Ge tunnel diodes is positive, whereas for As-doped Ge it is negative for the same electron concentration. This is attributed to a decrease in the degeneracy temperature, for a given carrier concentration, as a result of As doping. G.C.Williams

11316 ON THE INTERPRETATION OF THE CHARACTERISTIC OF THE TUNNEL DIODE AND ITS TEMPERATURE DEPENDENCE. G.Winstel.
Z. Naturforsch. (Germany), Vol. 16a, No. 4, 438-40 (April, 1960). In German.

Reports largely experimental investigations of the various parts of the characteristic, i.e. the diode current, the excess current and the Esaki current. P.T.Landsberg

11317 GALLIUM ARSENIDE ESAKI DIODES FOR HIGH-FREQUENCY APPLICATIONS. C.A.Burrus.
J. appl. Phys. (USA), Vol. 32, No. 6, 1031-6 (June, 1961).

Esaki diodes which show promise of usefulness into the millimetre-wave region have been made from both p- and n-type gallium arsenide. Both diodes were alloyed junctions having point contact geometry and dimensions. The fabrication of these diodes is briefly described, and their initial performance as oscillators in mechanically simple circuits is discussed. Fundamental oscillations to 103 kMc/s were obtained.

11318 HIGH-FREQUENCY SILICON VARACTOR DIODES. C.A.Burrus.
J. appl. Phys. (USA), Vol. 32, No. 6, 1166-7 (June, 1961).

The effective cut-off frequency of varactor diodes was raised to 1000 kMc/s by the use of point contact diode geometry. Using points of the group III and V elements, zero bias junction capacitances of less than 0.02 $\mu\mu$F were obtainable. Such diodes have provided broad-band gain and oscillation at 30 kMc/s. P.A.Walker

11319 EFFECT OF SURFACE CURRENTS OF THE CHARACTERISTICS OF FORMED POINT-CONTACT RECTIFIERS. R.Ebhardt, E.Hofmeister and E.Groschwitz.
Z. angew. Phys. (Germany), Vol. 13, No. 1, 16-28 (Jan., 1961). In German.

The current–voltage characteristics of diodes fabricated under controlled conditions from monocrystalline Ge of known resistivity and lifetime were carefully measured and interpreted in terms of the theoretical contributions due to (a) a hemispherical p-n junction, assumed to be produced by the forming process, in parallel with (b) the surface-barrier p-n junction due to an assumed inversion layer on the Ge surface surrounding the formed region, using the theory developed by the authors in previous papers. It is concluded that the surface current contribution plays a dominant part in determining the magnitude and form of the overall characteristic. F.F.Roberts

11320 USE OF MONOMOLECULAR LAYERS IN EVAPORATED-FILM TUNNELLING DEVICES.
J.L.Miles and H.O.McMahon.
J. appl. Phys. (USA), Vol. 32, No. 6, 1176-7 (June, 1961).

Devices for studying tunnelling currents through thin insulating films were prepared by separating evaporated metal films with a monolayer of barium stearate. Reproducible devices were not obtained because of the stringent geometrical requirements. Ageing effects are associated with atomic diffusion between the metal and the insulating film. J.Holt

Photoconductivity

11321 OPTICAL AND ELECTRICAL PROPERTIES OF TERNARY CHALCOGENIDES.
J.A.Beun, R.Nitsche and M.Lichtensteiger.
Physica (Netherlands), Vol. 27, No. 5, 440-52 (May, 1961).

Single crystals of various ternary chalcogenides of the formula AB_2X_4 (where A = Zn, Cd, Hg; B = In, Ga; X = S, Se) were grown from the vapour phase by means of a chemical transport reaction. These compounds are n-type photoconductors with the fundamental absorption edge in the visible or near-infrared part of the spe ru Photoelectric properties of these materials, such as: spectra dependence of the photocurrent, optical absorption, band gap, lif and dark resistance, gain, sensitivity, carrier lifetime, Hall mob and photoelectric decay time are reported.

11322 PULSE PHOTOCONDUCTION AND CARRIER LIFE TIME IN CdS SINGLE CRYSTALS.
J.Shirafuji and Y.Inuishi.
J. Phys. Soc. Japan, Vol. 15, No. 7, 1346 (July, 1960).

The temperature dependence of the time constants and the e value of photocurrent, were measured with short duration light pulses (0.5 μsec) or with chopped light (5 msec). The CdS crysl which were formed either by the sublimation process or from te melt, were undoped. It is shown that the shorter of the two dec constants, associated with the photocurrent produced by the puls light, is sensitive to surface conditions. A.J

11323 A CHEMICAL METHOD OF SENSITIZING A CdS FIM FORMED BY SINTERING. M.Zöllei.
Acta phys. chem. Szeged. (Hungary), Vol. 3, No. 1-4, 21-6 (1957 In German.

By means of sintering an almost homogeneous semiconductg CdS film of great mechanical strength can be produced from a C suspension and a CdS colloidal solution. A new method was usec for the sensitization of CdS films using the halogens. In this me the halogens are introduced into the CdS during the sintering process using the appropriate Cl, Br, or I ammonium salt. A.J

11324 PHOTOSENSITIVITY AND SPEED OF RESPONSE I CADMIUM SULPHIDE. D.Shaw.
Brit. J. appl. Phys., Vol. 12, No. 7, 337-41 (July, 1961).

The photoconductivity and photocurrent decay time at 875 f candles illumination have been measured for over ninety crysta of cadmium sulphide of widely different photosensitivities. The same parameters were also measured over the illumination ran 0·007 to 875 foot candles for a smaller number of crystals. At 875 foot candles a clear correlation between photoconductivity a decay time was observed. The performance of all the crystals was limited by trapping. Evidence for two types of trap was obtained.

11325 INVESTIGATION OF GERMANIUM BY PHOTOELECTRIC METHODS.
V.A.Petrusevich, V.K.Subashiev and G.P.Morozov.
Fiz. tverdovo Tela (USSR), Vol. 3, No. 5, 1505-14 (May, 1961). In Russian.

It has been shown previously that the surface recombinatio velocity, diffusion length, and absorption coefficient can be relatively simply determined from the spectral distribution of t photoconductivity. The present results provide verification of these methods by comparison with measurements of the photomagnetic effect. The combination of the photomagnetic effect a the spectral distribution of the photoconductivity is used to dete mine the ambipolar diffusion coefficient, the resistivity, and typ of conductivity of the semiconductor. [English translation in: Soviet Physics–Solid State (USA)]. D.J.Hu

11326 EFFECTS OF PREVIOUS HEAT-TREATMENT ON T PHOTOCONDUCTIVITY OF AN X-RAYED NaCl CRYSTAL. I.Tar'yan, R.Uoska and S.Shomlo.
Kristallografiya (USSR), Vol. 5, No. 2, 323-4 (March-April, 196 In Russian.

The variation on the concentration of F centres produced by irradiation is shown to depend on the heat treatment history in artificial crystals. This can be simulated by heat treating natur crystals. [English translation in: Soviet Physics – Crystallogr (USA), Vol. 5, No. 2, 302 (Sept.-Oct., 1960) . W.Bard

11327 LONG-PERIOD DECAY OF THE PHOTOCONDUCTIVI AND THE PHOTODIELECTRIC EFFECT IN ZINC OXIDE. J.Roux.
Arch. Sci.(Switzerland), Vol. 13, No. Fasc. Spec., 95-9 (Sept., 1 In French.

This article is concerned with photoconductivity and photodielectric effect decays measured over several months after ir tions which exceed 10 hours. The effects were measured simul taneously on the same specimen, which was a paste of commerc zinc oxide in a paraffin matrix placed between aluminium plates which were separated by 1 to 2 mm. White light, radiation mai comprised by the wavelength 3650 A, and X-ray stimulation wer

ed. The conductivity measurements were made with a stone bridge. The permittivity was measured between 12.5 c/s kc/s. All measurements were at ambient temperature with a zing voltage of a few volts. The photoconductivity decay is of r form for all samples and is provisionally divided into three s, during which the conductivity falls by a factor of 10^6. ttivity measurements show that in the intermediate, relatively period, region no appreciable dispersion occurs, although the ctivity falls by a factor of 100 to 1000. The results are inter- on the basis of a model involving initially the optical excita- charge carriers, then trapping and subsequent release by al activation. It is assumed that carriers of one charge type itially liberated much more rapidly than those of the other type iat, during the intermediate decay period, both types are liber- t the same rate, giving rise to an overall neutralization of e. P.J.Dean

328 THE THEORY OF THE TRANSVERSE PHOTOMAGNETIC [PHOTOELECTROMAGNETIC] EFFECT. A.A.Grinberg. verdogo Tela (USSR), Vol. 3, No. 1, 94-6 (Jan., 1961).
ssian.
roceeds from previous work (Abstr. 15981 of 1960) to calcu- he effect in an isotropic p- or n-type semiconductor. It is t that the sign of the effect can change for both types even ut two kinds of hole. This occurs when the mobility of the rity carriers is several times greater than that of the minority ers. [English translation in: Soviet Physics—Solid State (USA), 3, No. 1, 69-70 (July, 1961)]. R.Berman

ermoelectric Properties

CALCULATION OF THERMOELECTRIC COEFFICIENTS. Abstr. 10449

THERMOELECTRIC POWER OF TRANSITION METALS IN PPER—GOLD ALLOYS. See Abstr. 11254

ELECTRICAL CONDUCTIVITY AND THERMOELECTRIC ECT IN SINGLE-CRYSTAL TiC. See Abstr. 11260

electric Properties

11329 ELECTRICAL PROPERTIES OF SOME MIXED FERRITES IN ALTERNATING ELECTRIC FIELDS. .Sinyakov and V.P.Avramenko.
tverdogo Tela (USSR), Vol. 3, No. 2, 411-15 (Feb., 1961). Russian.
For abstract, see Abstr. 10081 of 1961. [English translation Soviet Physics—Solid State (USA), Vol. 3, No. 2, 299-303 (Aug., 61)].

11330 DIELECTRIC AND OPTICAL PROPERTIES OF ZINC SULPHIDE MATERIALS. É.V.Stauér and V.P.Izotov.
. Akad. Nauk SSSR, Ser. fiz., Vol. 24, No. 2, 224-8; Disc. 242-5 960). In Russian.
"1958 Moscow Dielectrics Conference" (see Abstr. 16003 of 60). Complex permittivity of electroluminescent and non- ectroluminescent ZnS powders was studied as a function of the tensity and frequency of the applied field, temperature and surface eatment. The temperature dependence of the intensity and ectrum of electroluminescence was also investigated. Some of e observed effects are related to conducting ZnO layers on ZnS wder particles. A.Tybulewicz

11331 DETERMINATION OF THE EFFECTIVE IONIC CHARGE OF GALLIUM ARSENIDE FROM DIRECT EASUREMENTS OF THE DIELECTRIC CONSTANT.
.G.Hambleton, C.Hilsum and B.R.Holeman.
roc. Phys. Soc. (GB), Vol. 77, Pt 6, 1147-8 (June, 1961).
Direct measurements of static and optical dielectric constants ere made on GaAs with a resistivity of 10^9 ohm cm at room emperature. Values obtained were $\epsilon_0 = 12.5(3)$ and $\epsilon_\infty = 10.90$. An ffective ionic charge e_s^* of 0.46e can be deduced from these values.

11332 POLARIZATION AND DIFFUSION IN A SILICATE GLASS. R.J.Charles.
. appl. Phys. (USA), Vol. 32, No. 6, 1115-26 (June, 1961).
The self-diffusion of alkali ions in alkali silicate glasses is discussed in terms of the formation, migration, and ultimate annihilation of defects. These defects exhibit a combination of the properties exhibited by Frenkel defects in alkali halides and Bjerrum defects in ice, and are treatable by many of the analytical techniques which are applicable to defects in crystalline solids. By utilizing the defect concept, relationships between self-diffusion, a.c. and d.c. conductivity, and orientational polarization are obtained.

11333 PROPERTIES OF POLYVINYLIDENE FLUORIDE. I. DIELECTRIC MEASUREMENTS. T.Wentink, Jr.
J. appl. Phys. (USA), Vol 32, No. 6, 1063-4 (June, 1961).
Dielectric constant (K) and loss tangent (tan δ, the dissipation factor) measurements on the plastic polyvinylidene fluoride were made over the frequency range 50 c/s to 9800 Mc/s at room temperature. Pronounced anomalous dispersion in K and a peak in tan δ near 10 Mc/s were observed. Theoretical and practical applications of the data are briefly mentioned. This material has an unusually high dielectric constant and is quite lossy, especially when compared to the chemically and structurally related plastics polyethylene and polytetrafluoroethylene.

11334 DIELECTRIC PROPERTIES AND SIDE-CHAIN CRYSTALLINITY OF POLYVINYL STEARATE.
M.G.Broadhurst, E.R.Fitzgerald and A.J.Bur.
J. appl. Phys. (USA), Vol. 32, No. 6, 972-6 (June, 1961).
Measurements of the real (ε') and imaginary (ε'') parts of the dielectric constant were made on polyvinyl stearate at temperatures from −50° to +80° C and over a frequency range from 100 to 50 000 c/s. Although no full relaxation dispersion region was found in this frequency range, there are indications of the beginnings of a high-frequency dispersion region just above the freezing point (49.1° C) in the liquid polymer. This dispersion cuts off or is "frozen in" rapidly as the sample freezes, giving evidence of a slight rotational freedom in the solid polymer near the freezing and melting points. Because of this "freezing in" of the dispersion mechanism it is supposed that the dipolar side chain is unable to rotate in the solid form because of the combined effects of the side-chain crystalline field and angle which the C—O bond (between the main chain and side chain of the polymer) makes with the side-chain axis. Specific volume measurements were made to supplement the above work. The measurements show that a quickly frozen sample will melt at a lower temperature (52.5° C) than a slowly frozen sample (55.0° C). Also, discontinuities in the slope of the specific volume versus temperature curve are related to changes in the imaginary part of the dielectric constant and to changes in mechanical dispersion data. The results are compared with those for other polymers.

11335 ANOMALOUS CAPACITANCE OF THIN DIELECTRIC STRUCTURE. C.A.Mead.
Phys. Rev. Letters (USA), Vol. 6, No. 10, 545-6 (May 15, 1961).
Capacitance (C) and tunnel voltage (V_T) measurements, on tantalum oxide films on a tantalum sheet, show that a plot of 1/C versus V_T intercepts at 0.05 mil$^2/\mu\mu$F if the counter-electrode is gold and 0.09 mil$^2/\mu\mu$F with a bismuth counter-electrode, i.e. the dielectric layer is about 2.75 A thick with gold and 5.5 A thick with bismuth, which has a greater penetration factor. J.H.Mason

DECAY OF THE PHOTODIELECTRIC EFFECT IN ZINC OXIDE. See Abstr. 11327

NUCLEAR MAGNETIC RESONANCE IN FERROELECTRIC SYSTEMS. See Abstr. 11496

11336 FERROELECTRICITY IN POTASSIUM FERROCYANIDE TRIHYDRATE AND ITS ISOMORPHOUS SUBSTANCES.
S.Waku, K.Masuno, T.Tanaka and H.Iwasaki.
J. Phys. Soc. Japan, Vol. 15, No. 7, 1185-9 (July, 1960).
Several $A_4[M(CN)_6]\cdot 3H_2O$ type cyano-complexes belonging to the crystal class C_{3h} were studied to examine ferroelectricity. Isomorphous substances obtained through replacing the Fe^{++} ion by Ru^{++}, Os^{++} and Mn^{++} ions show ferroelectric behaviour below −14° C, −2.4° C and −40° C respectively. Ferroelectric behaviour of these compounds is very similar to that of the potassium ferrocyanide trihydrate, reported before. The potassium ferrocyanide group ferroelectrics has a ferroelectric axis parallel to [101] direction. Ferroelectric transition of these substances is probably of the second order.

11337 ON SOME DIELECTRIC PROPERTIES OF METHYL AMMONIUM ALUM. S.Le Montagner and M.M.Rousselot.
J. Phys. Radium (France), Vol. 21, No. 10, 756-7 (Oct., 1960). In French.

The real and imaginary parts of the dielectric constant of methyl ammonium alum were measured as a function of temperature in the frequency range from 50 c/s to 5 Mc/s. A sharp change in slope was observed for ϵ' as a function of temperature at about 140°K, a maximum in $\epsilon''(T)$ which is a function of frequency, and a secondary maximum in $\epsilon''(T)$ which appeared at 150°K. The secondary maximum is attributed to a hysteresis effect in the applied field. The activation energy of the ferroelectric phase determined from the displacement of the maximum of $\epsilon''(T)$ as a function of frequency is 0.22 eV. The heat of transition was also measured by comparison with KH_2PO_4 yielding a value of between 250 and 370 cal per mole depending on the heat of transition chosen for KH_2PO_4. This energy corresponds to an elementary molecular energy of about 0.01 eV which is an order of magnitude smaller than the energy contained in the applied field. It is possible that this effect can account for the difference in Curie points measured by different techniques.
P.E.Seiden

11338 INCREASE IN DIELECTRIC CONSTANT DURING SWITCHING IN LITHIUM SELENITE AND TRIGLYCINE SULFATE. E.Fatuzzo.
J. appl. Phys. (USA), Vol. 32, No. 8, 1571-9 (Aug., 1961).

The dielectric constant of lithium selenite and triglycine sulphate was measured during switching up to frequencies of 100 Mc/s. The increase in dielectric constant during switching was found to decrease with frequency v as $1/v$ at low frequencies and as $1/v^2$ at high frequencies. A model to explain the experimental results is given and discussed. It is shown that information about the domain wall mass can be obtained from this kind of measurement.

11339 RELATION BETWEEN THICKNESS AND DIELECTRIC PARAMETERS FOR PLATES OF TRIGLYCINE SULPHATE. A.S.Sonin and V.V.Gladkii.
Kristallografiya (USSR), Vol. 5, No. 1, 145-7 (Jan.-Feb., 1960). In Russian.

Plates of triglycine sulphate were cut perpendicularly to the single crystal ferroelectric axis, and ground to various thicknesses. Silver electrodes were deposited on them by vacuum evaporation. Two electrode forms were used: (i) the full working area of 100 mm^2; (ii) crosses of working area one mm^2. Electrical parameters were measured at 50 c/s with a field of 2.4 kV/cm. It was found that as the thickness decreased the coercive field increased and the spontaneous polarization decreased, for the continuous electrodes and a thickness less than 0.06 mm. Both functions increased with decreasing thickness for cross electrodes. Curves of polarization-reversal time and current had the usual shape. The cause of such variations with thickness is that there are surface layers whose polarization directions are opposed to that of the main body of the crystal. The method of cutting and metallizing seriously affects the parameters. [English translation in: Soviet Physics—Crystallography (USA), Vol. 5, No. 1, 136-7 (July-Aug., 1960)]. R.V.Coates

11340 INTERFEROMETRIC STUDY OF DOMAIN STRUCTURE IN BARIUM TITANATE. V.G.Bhide and N.J.Bapat.
Physica (Netherlands), Vol. 27, No. 6, 531-40 (June, 1961).

The surface microtopography arising out of the 90° domain walls in single crystals of barium titanate in the ferroelectric tetragonal state was studied in detail employing optical and multiple beam interferometric techniques. The domain walls mark a change in level at the crystal surface and it is shown that the change in level is proportional to the distance between the domain walls. A step-ladder structure is often found on the crystal surface which indicates the head to tail coupling of the dipoles. In a few cases, however, 90° wall configuration with head to head or tail to tail orientation was observed. These laminae frequently advance in groups in the two perpendicular directions parallel to the edges of the crystal. As a result of the intersection of these groups, the crystal surface becomes highly complicated with a step-ladder structure in mutually perpendicular directions, terminating in a square base or at times in a point. In many cases, the multiple beam interferometric techniques showed that the crystal surface is deformed with a cylindrical curvature; the axis of a cylinder being parallel to the edge of the crystal. Some times the crystal is observed to have cylindrical curvatures in perpendicular directions.

11341 DIELECTRIC PROPERTIES OF $BaTiO_3$ SINGLE CRYSTALS IN THE PARAELECTRIC STATE FROM 1 kc/sec TO 2000 Mc/sec. E.Stern and Allen Lurio.
Phys. Rev. (USA), Vol. 123, No. 1, 117-24 (July 1, 1961).

The dielectric constant of $BaTiO_3$ single crystals in the reg above the 120°C Curie point was measured at several frequencie in the range from 1 kc/s to 2000 Mc/s. In addition, the B coeffi in Devonshire's equation [Phil. Mag. (GB), Vol. 3, No. 10, 85-13 (1954)] for the free energy was studied at 500 Mc/s. It is shown that the crystal is completely clamped with respect to the measu field at 500 Mc/s so that the coefficient of the P^4 term in Devonshire's equation is positive and agrees with the expected theoretical result of $B_P^C = 2.23\times10^{-13}$ c.g.s. unit.

11342 NONLINEARITY AND MICROWAVE LOSSES IN CU STRONTIUM-TITANATE.
G.Rupprecht, R.O.Bell and B.D.Silverman.
Phys. Rev. (USA), Vol. 123, No. 1, 97-8 (July 1, 1961).

The complex dielectric constant of single-crystal strontiun titanate was measured from 90° to 230°K at microwave frequen The real part of the dielectric constant consists of a large field independent contribution which obeys a Curie—Weiss law over t entire range of measurement plus a smaller anisotropic field-dependent contribution. These results are shown to be in qualit agreement with the theory of ferroelectricity in perovskite stru as proposed by Slater (Abstr. 7972 of 1950). The observed loss tangent consists of a contribution which is quadratic in an appli biasing field plus a field-independent contribution. The field-independent loss tangent goes through a minimum at about 170° a much steeper slope on the low-temperature side of the minim than on the high-temperature side. The origin of the behaviou the field-independent loss tangent is discussed.

11343 JUMP PHENOMENON IN RESONANCE CURVE OF FERROELECTRIC CERAMICS. K.Negishi.
J. Phys. Soc. Japan, Vol. 15, No. 3, 534 (March, 1960).

Disc specimens of lead zirconate-titanate ceramic, excited in the radial mode, show normal mechanical resonance curves (Q=1700) at small driving fields, but unsymmetrical curves at fields of 5 to 50 V/cm. K.W.Ples

11344 KINEMATIC THEORY OF FERROELECTRIC DOMA GROWTH. T.Nakamura.
J. Phys. Soc. Japan, Vol. 15, No. 8, 1379-85 (Aug., 1960).

Sidewise motion of the 180° wall in ferroelectric barium titanate is described, applying the kinematic wave theory develo by Lighthill—Witham [Proc. Roy. Soc. (GB), Vol. 229, 281 (1955 The peculiar shapes of the domain in growing and in shrinking processes, observed by Miller (1959) and Husimi (1960), can be derived purely kinematically. The 180° wall is described as an assembly of steps. Orientation of the wall is described by step density. There is a part of constant orientation that moves with constant velocity, which is shown to be identical to the kinemati wave velocity. Rounded squares observed in the growing proces and straight domain fronts in the shrinking process are fairly w explained as a result of propagation of kinematic waves, assumi suitable functional relationship between the velocity and the den of the progressing steps. Discontinuity of wall orientation is interpreted as a "kinematic shock wave".

11345 ELECTRIC STRENGTH OF RUTILE SINGLE CRYST D.A.Powers and I.J.T.Johansen.
J. appl. Phys. (USA), Vol. 32, No. 6, 1083-5 (June, 1961).

The breakdown strength of rutile crystals was measured ∥ ⊥ to the optic axis. The d.c. breakdown is a thermal process occurring at a power level of 2 kW/cm^3 for the particular samp size and the test cell used, with field strengths of 20 kV/cm t the axis and 120 kV/cm⊥. Impulse measurements at 1 μsec ri time required special techniques of sample and electrode prepa in order to prevent field distortion and surface breakdown. Bre down strengths of 570 kV/cm ⊥ and 690 kV/cm ∥ to the optic a were measured.

11346 PERSPEX ELECTRETS.
C.S.Bhatnagar.
Current Sci. (India), Vol. 30, No. 1, 11-12 (Jan., 1961).

The study of Perspex electrets, formed at temperatures between 120°C and 160°C using fields from 8 to 20 kV/cm, show that for temperatures above 150° C the initial charge is a hetero charge and for temperatures below 140° C it is a homocharge. final charge in all cases is a homocharge and its magnitude de on both the temperature and the polarizing field. The results ob tained are in agreement with Gross's theory. Z.Kras

OPTICAL PROPERTIES OF SOLIDS

(Including X-ray Spectra)

11347 ELECTROMAGNETIC WAVE PROPAGATION IN MOLECULAR CRYSTALS WITH WEAK EXCITON–PHONON INTERACTION. I. ABSORPTION AND DISPERSION OF ELECTROMAGNETIC WAVES. A.F.Lubchenko.
Ukrayin. fiz. Zh. (USSR), Vol. 3, No. 5, 575-86 (1958). In Ukrainian, with summary (1½ pp.) in Russian.

The author studied the absorption and dispersion of electromagnetic waves in molecular crystals in which excitons may be formed with weak coupling of the exciton excitation with the lattice vibrations and at an arbitrary value of the absorption coefficient κ. The energy operator of the interaction between the electromagnetic wave and the crystal is taken in an appropriate form; the wave vector Q of the wave propagated in the crystal is regarded as complex. The wave-function describing the excited state of the crystal is found. After determining the latter, a calculation is made of the electrical moment of a crystal unit volume, arising under the effect of electromagnetic excitation. In what follows it is assumed for simplicity of calculation that the exciton zone in question is distant from the other zones, and that the polarization, due to transitions to all other states except the one under examination, is as is equal to $(\epsilon - 1)E/4\pi$, where the dielectric constant tensor ϵ depends only to a slight extent on the frequency. The expression for polarization, in conjunction with the Maxwell equations, permits one obtaining of a simple system of equations for determining n, κ and E. The system found is solved for crystals of the monoclinic system, when the transition occurs in a state, the wave-function of which is transformed by the same irreducible representation as is the z-component of the polar vector. It is shown that if light is propagated along the 0x axis, other n^2 values are obtained in addition to the ordinary classical crystaloptic solution in the transparent region ($n^2 = \epsilon_2$). They can be determined from a cubic equation in n^2; furthermore, depending on the coefficients, the equation may have one root $n^2 > 0$ and two imaginary roots, or three real roots. Each root $n^2 > 0$ has its corresponding κ. Therefore in the first case (one root $n^2 > 0$) two waves are propagated in the crystal: one, with an index of refraction $\sqrt{\epsilon_2}$ and κ = 0, polarized along 0y; and the second with $n^2 > 0$ and κ = 0, polarized along 0z. In the second case the crystal will contain, besides the wave polarized along 0y (n = $\sqrt{\epsilon_2}$, κ = 0), coherent waves polarized along 0z with various absorption coefficients. In this case, it becomes necessary to revise the phenomenological definition of the absorption coefficient. A calculation of n, κ and E is carried out, in the same way as for monoclinic system crystals, for crystals of other syngonies, the qualitative results being similar.

11348 PROPAGATION OF ELECTROMAGNETIC WAVES IN MOLECULAR CRYSTALS WITH WEAK EXCITON–PHOTON INTERACTION. II. NATURAL OPTICAL ACTIVITY. A.F.Lubchenko.
Ukrayin. fiz. Zh. (USSR), Vol. 3, No. 6, 701-11 (1958). In Ukrainian.

For Pt I, see preceding abstract. The gyration vector is calculated for crystals in which excitons arise in the case of a weak coupling of the exciton excitation with the lattice vibrations and an arbitrary value of the coefficient of absorption κ. The expression obtained in Pt I for the light-wave-induced electric moment of a unit volume crystal in the region of exciton absorption is written in a different form, where the moments $P_2(m)$ and $P_3(m)$ are defined by the sum of two series. These moments are then represented in the form of the product of the symmetrical tensor and the light-wave field intensity in the crystal. The symmetrical tensor is later written as the sum of the symmetrical and antisymmetrical tensors; then, applying the fact that the antisymmetrical tensor is equivalent to the axial vector, the expressions for $P_2(m)$ and $P_3(m)$ are written in a simplified form. The sum of the axial vectors G_1 and G_2 defines the gyration vector G. The symmetrical tensors make some contribution to the polarization tensor, but since they are proportional to a/λ, this contribution is neglected in the present paper. Applying the expression obtained for P(m), the induction vector is determined, and then, applying Maxwell's equation for plane waves, one finds a system which defines the complex index of refraction in the presence of rotation. Excluding from this system the components of vector E, one obtains an equation which is then solved for crystals of cubic, trigonal, tetragonal, hexagonal and rhombic symmetries near the exciton absorption band with various directions of the wave normal and for transitions into states of various symmetry. Thus, one determines the indices of refraction n'_+, n''_+, n'_-, n''_- and the specific rotation of molecular crystals $\theta\pm$ near the region of exciton absorption. It follows that near the exciton absorption band, the $\theta\pm$ curve differs essentially from the classical one when the exciton effective mass is positive; at a distance from the exciton absorption region, the expression for $\theta\pm$ is reduced to the classical expression.

11349 PROPAGATION OF ELECTROMAGNETIC WAVES IN MOLECULAR CRYSTALS WITH WEAK EXCITON–PHONON INTERACTION. III. MAGNETO-OPTICAL EFFECTS. A.F.Lubchenko.
Ukrayin. fiz. Zh. (USSR), Vol. 4, No. 2, 183-200 (1959). In Ukrainian.

For Pt II, see preceding abstract. The author calculates the gyration vector due to the rotation of the polarization plane in the outer magnetic field (the Faraday effect). Formulae are obtained which determine the dispersion of the Verde coefficient for crystals of cubic symmetry and crystals of medium symmetries, when light is propagated along the axis of highest order (C_3, C_4, C_6) near the exciton light absorption band; the values for the indices of refraction in this region are determined for crystals of cubic, tetragonal and rhombic symmetries. Formulae are derived determining the double refraction and its dispersion in a magnetic field (the Cotton-Mouton effect) for crystals of cubic symmetry. The author shows that allowing for space dispersion results in a dispersion of the Verde and Cotton-Mouton coefficients differing from the classical one; at a distance from the region of exciton absorption, the expressions derived in this paper are reduced to the formulae of classical optics.

11350 INTERACTION OF LIGHT WITH IMPURITY CENTRES IN THE CASE OF INTERMEDIATE COUPLING. V.V.Lŷtvŷnenko.
Ukrayin. fiz. Zh. (USSR), Vol. 3, No. 5, 690-3 (1958). In Ukrainian.

11351 OPTICAL AND STRUCTURAL ANOMALIES IN POTASSIUM FERROCYANIDE TRIHYDRATE CRYSTALS. H.Toyoda, N.Niizeki and S.Waku.
J. Phys. Soc. Japan, Vol. 15, No. 10, 1831-41 (Oct., 1960).

Crystals grown from aqueous solution were studied with a polarizing microscope, X-ray diffraction methods, etching technique, and dielectric measurements in a temperature region between 20° and -140°C. Various types of optical anomalies were observed, and the crystals were classified into five types by optical and X-ray investigations. Crystallographic data of monoclinic and tetragonal single crystals were measured. The various optical anomalies were clarified by twinning and parallel growth characteristics in the layer structure of the two modifications. Dislocation pits were observed by etching with a mixture of water and alcohol. The ferroelectric monoclinic phase, and the behaviours of the tetragonal phase at low temperatures were studied by a polarizing microscope, dielectric measurements and low temperature precession X-ray photographs. The tetragonal phase was shown to undergo a monotropic transition at about -55°C, and a transformation into a twinned monoclinic phase.

11352 IRIDESCENT $KClO_3$ CRYSTALS AND INFRARED REFLECTION FILTERS. J.Strong.
J. Opt. Soc. Amer., Vol. 51, No. 8, 853-5 (Aug., 1961).

Measurements of the sharp reflection peaks of two iridescent potassium chlorate crystals are presented, together with theoretical calculations based on Lord Rayleigh's model that the reflection is due to a stratified "grating-in-depth," formed by evenly spaced layers of low reflectance. The possibility of such structures for filters useful in the far infrared is pointed out.

11353 THE TEMPERATURE DEPENDENCE OF THE REFRACTIVE INDEX OF SILICON. F.Lukeš.
Czech. J. Phys., Vol. 10, No. 4, 317-26 (1960). In German.

The dependence of the refractive index n of silicon on the temperature T is reported in the wavelength range 1.1-5.5 μ and in the temperature range 109°-750°K. The relationship n = f(T) is non-linear and for temperatures > 170°K, n is proportional to T^2. The experimental values of dn/dt agree with the values predicted by classical theory. A.J.Fox

11354 VARIATION WITH TEMPERATURE OF THE PHOTOELASTIC CONSTANTS OF SODIUM CHLORIDE. K.V.Krishna Rao and V.G.Krishna Murty.
Nature (GB), Vol. 190, 429-30 (April 29, 1961).

Presents values for the stress and strain-optical constants

of sodium chloride which were measured over the temperature range 30° to 300° C for a wavelength of 5890 A using Filon's method in a modified form. A.E.Kay

11355 VARIATION OF THE ROTATORY POWER IN AN OPTICAL ANTIPODE, PRODUCED BY 2 MeV ELECTRONS. A.Carrelli and F.Porreca.
Nuovo Cimento (Italy), Vol. 19, No. 4, 844-6 (Feb. 16, 1961).

The effect of irradiation by 2 MeV electrons on the optical activity of the following stereoisomers was studied: d- and l-quartz, d- and l-alanine, d- and l-tartaric acid, d-ammonium tartrate, quinine and quinidine, cinchomine and cinchoridine.
G.I.W.Llewelyn

11356 THEORY OF INTERBAND FARADAY ROTATION IN SEMICONDUCTORS. B.Lax and Y.Nishina.
Phys. Rev. Letters (USA), Vol. 6, No. 9, 464-7 (May 1, 1961).

The Faraday rotation and its dependence on wavelength are calculated for indirect and direct forbidden transitions. This is an extension of the theory due to Lax (Abstr. 12016 of 1959), in which the Faraday rotation is interpreted in terms of virtual interband transitions associated with the direct transitions. A.J.Fox

11357 KERR MAGNETO-OPTIC EFFECT IN NICKEL–IRON FILMS. I. EXPERIMENTAL. P.H.Lissberger.
J. Opt. Soc. Amer., Vol. 51, No. 9, 948-56 (Sept., 1961).

An account is given of experiments to determine the magnitude of the Kerr magneto-optic effect in thin films of nickel (83%) iron (17%) alloy and the results discussed with a view to possible applications in computer storage systems. It is shown that the magnitude of the effect in relation to inherent background fluctuations (signal-to-noise ratio) can be appreciably increased by a suitable dielectric (zinc sulphide) layer deposited onto the NiFe films. The improvement, however, is found to depend critically on the thickness of the dielectric layer and on the spectral composition of the illumination in the measuring equipment. These facts, as well as the general lack of agreement in previously published results, are clarified by measurements of the dispersion of the Kerr rotation in NiFe films coated with various thicknesses of ZnS.

FREE-CARRIER INFRARED ABSORPTION IN SEMICONDUCTORS. See Abstr. 11282

OPTICAL MASER EFFECTS IN $CaF_2:Sm^{++}$. See Abstr. 11397

11358 KERR MAGNETO-OPTIC EFFECT IN NICKEL–IRON FILMS. II. THEORETICAL. P.H.Lissberger.
J. Opt. Soc. Amer., Vol. 51, No. 9, 957-66 (Sept., 1961).

Formulae are established which account for the performance of the type of equipment necessary for the measurement or application of the Kerr magneto-optic effect in ferromagnetic films. Furthermore, a theory is developed to describe the modification of the Kerr effect by dielectric layers deposited on the ferromagnetic surfaces. The resulting formulae satisfactorily describe the appropriate dispersion curves given in Pt I.

11359 A THEORY OF THE MAGNETO-OPTICAL ABSORPTION. M.Okazaki.
Progr. theor. Phys. (Japan), Vol. 25, No. 2, 163-77 (Feb., 1961).

A theory of the magneto-optical absorption is developed by means of the Luttinger and Kohn theory (Abstr. 3742 of 1955) of the effect of magnetic field on the energy bands in the case of a simple band model. The main purpose is to study the absorption line-shape. The width of the absorption line obtained agrees with experiment. It does not exhibit appreciable dependence on the magnetic field and temperature. The absorption coefficient in the absence of a magnetic field is also discussed.

11360 LATTICE ANHARMONICITY AND OPTICAL ABSORPTION IN POLAR CRYSTALS. II. CLASSICAL TREATMENT IN THE LINEAR APPROXIMATION.
A.A.Maradudin and R.F.Wallis.
Phys. Rev. (USA), Vol. 123, No. 3, 777-89 (Aug. 1, 1961).

An expression for the elements of the dielectric susceptibility tensor for an ionic crystal was derived in a manner analogous to that employed by Kubo in his treatment of magnetic susceptibility. In the high-temperature (classical) limit, this expression reduces to the Laplace transform of the autocorrelation function of the single normal coordinate which interacts directly with the external radiation field. The authors applied this formalism to the calculation of the high-temperature linear optical absorption coefficient of an anharmonic ionic crystal for which only cubic anharmonic terms were retained in the lattice Hamiltonian. The authors solved directly for the Laplace transform of the autocorrelation function to lowest order in the anharmonic coupling constant by solving the equation of motion for the normal coordinates after they have been linearized. The linear absorption coefficient obtained from the susceptibility tensor is of Lorentzian form with a frequency-dependent damping constant which varies linearly with temperature. The absorption coefficient for a diatomic linear chain with nearest-neighbour interactions was evaluated.

11361 FINE STRUCTURE IN THE ABSORPTION AND FLUORESCENCE SPECTRA OF CERTAIN PIGMENTS AT 77° K. F.F.Litvin and R.I.Personov.
Dokl. Akad. Nauk. SSSR, Vol. 136, No. 4, 798-800 (Feb. 1, 1961). In Russian.

For abstract, see Abstr. 7707 of 1961. [English translation in Soviet Physics–Doklady (USA), Vol. 6, No. 2, 134-6 (Aug., 1961)]

11362 LINE SHAPE OF ULTRAVIOLET ABSORPTION IN SOLID NOBLE GASES. P.H.E.Meijer.
J. chem. Phys. (USA), Vol. 34, No. 6, 2078-82 (June, 1961).

The absorption of ultraviolet radiation in solid noble gases shows lines that are a few hundred inverse centimetres broad. An attempt is made to explain and calculate the width and shape of these lines on the basis of a tentative curve of energy versus configuration. It is shown that the width has the proper order of magnitude. The line shape can be easily calculated at the short wavelength end. It should show an exponential tail. If the expression is inspected for small values of the energy, a rapidly rising exponential is found, which will give rise to a smeared-out edge appearance. The line will have a nonsymmetrical shape.

ULTRAVIOLET ABSORPTION SPECTRUM OF AMMONIA IN SOLID ARGON AT 4.2° K. See Abstr. 10100

11363 OPTICAL ABSORPTION AND FLUORESCENCE OF OXYGEN IN ALKALI HALIDE CRYSTALS.
J.Rolfe, F.R.Lipsett and W.J.King.
Phys. Rev. (USA), Vol. 123, No. 2, 447-54 (July 15, 1961).

Single crystals of NaCl, KCl, and KBr were grown from the melt in an oxygen atmosphere, and their optical absorption, fluorescence excitation, and fluorescence emission spectra were measured at 300°, 77°, and 4.2° K. The weak absorption band caused by oxygen was the same in all three crystals, and did not vary with temperature. The band had maximum absorption at 5.0 eV and a half-width of 1.0 eV. All fluorescence excitation spectra contained a component identical to this absorption band. The fluorescence emission spectra consisted of a series of peaks in the wavelength range 4000-10 000 Å with an approximately equal energy separation of 1000 cm^{-1}. At 300° K, 12 to 15 peaks were resolved, and at 4.2° K each of these peaks split into 4 to 6 components. From these optical results and from paramagnetic resonance experiments, it is concluded that O_2^- molecule-ions located in anion sites in the crystal are responsible for the absorption and fluorescence.

11364 EFFECT OF PRESSURE AND TEMPERATURE ON THE ABSORPTION SPECTRA OF FOUR ALKALI HALIDE PHOSPHORS. A.S.Balchan and H.G.Drickamer.
J. chem. Phys. (USA), Vol. 35, No. 1, 359-61 (July, 1961).

The effect of pressure and temperature was measured on "A" bands in KI:Tl and in three alkali halides containing Pb^{++} impurity. The effect of temperature is to impose a red shift on the observed room-temperature pressure shift. The most remarkable result is the appearance of a new band in the high-pressure phase of KCl:Pb and KBr:Pb upon heating under pressure. The band remains after cooling, but disappears upon lowering the pressure into or through the region of the transformation back to the f.c.c. phase. Repressuring and reheating reintroduces the band. It seems most probable that the band is associated with the ionic configuration near the Pb^{++} ion, especially with the location of the accompanying K^+ vacancy.

11365 THE EFFECT OF DEFORMATION ON THE ABSORPTION SPECTRUM OF CUPROUS OXIDE CRYSTALS AT 20° K. V.V.Eremenko and L.I.Chuiko.
Optika i Spektrosk. (USSR), Vol. 9, No. 5, 621-5 (Nov., 1960). In Russian.

At low temperatures Cu_2O crystals exhibited two series of converging absorption bands, one of which was green and the other yellow. Under uniaxial compression the yellow series was displaced as a whole; this meant that the energy gap between its valence and conduction bands was changed. Behaviour of the green series (separate bands shifted by different amounts) indicated that its Rydberg constant was altered on compression, i.e. its effective

ctron or hole mass was affected. Effective carrier masses re found for the two series by assuming that they have a nmon conduction band and that they are due to optical transitions m separate valence bands to the exciton levels, and that the upper ges of the valence bands are separated by a gap represented by 100 cm^{-1} frequency interval between the limits of convergence the two series. [English translation in: Optics and Spectrosc. SA), Vol. 9, No. 5, 327-9 (Nov., 1960)]. A.Tybulewicz

11366 OPTICAL AND PHOTOELECTRIC PROPERTIES OF In_2Te_3. V.A.Petrusevich and V.M.Sergeeva.
z. tverdogo Tela (USSR), Vol. 2, No. 11, 2881-4 (Nov., 1960). Russian.

The optical absorption and the photoconductivity response ectra of α- and β-modifications of In_2Te_3 were recorded. Beyond e fundamental absorption edge the absorption coefficient (K) of th modifications was approximately the same and at large values K, the absorption spectra of α- and β-In_2Te_3 were similar. The rbidden band width deduced from the absorption spectra was 025 eV, i.e. about 0.1 eV greater than the band width deduced om the photoconductivity spectra. [English translation in: viet Physics—Solid State (USA)]. A.Tybulewicz

11367 EFFECT OF PRESSURE ON THE CHARGE TRANSFER SPECTRA OF HEAVY TRANSITION METAL HEXA-ALIDE COMPLEXES. A.S.Balchan and H.G.Drickamer.
chem. Phys. (USA), Vol. 35, No. 1, 356-8 (July, 1961).

The effect of pressure was measured on the charge transfer nds of seven hexahalide salts of heavy transition metal ions (with l and 5d configurations). The lowest energy peaks always exhibited large red shift with increasing pressure. Higher energy peaks ways showed less shift, and in one case actually shifted to the ne. While there are undoubtedly several factors involved, the ata are consistent with the assumption of increased spin—orbit upling at high pressure. The marked broadening of the bands can e discussed in terms of the effect of decreased lattice spacing on ie molecular charge transfer.

11368 INTERPRETATION OF THE ABSORPTION SPECTRA OF $K_3Fe(CN)_6$. C.S.Naiman.
. chem. Phys. (USA), Vol. 35, No. 1, 323-8 (July, 1961).

By interpreting the absorption spectra of $K_3Fe(CN)_6$ in solution, he results are explained of the pressure dependence of the solid spectra, obtained by Parsons and Drickamer (Abstr. 4442 of 1959). The intense absorptions at 24 000 and 32 900 cm^{-1} are identified as charge-transfer spectra from the ligand to the T_{2g} level of the metal ion, while the one at 38 460 cm^{-1} is identified as the same type of transition, but into the E_g level. Fitting of the weaker spectra yields the values of 3500, 720, and 3285 cm^{-1} for the crystalline field parameters Dq, B, and C, respectively. One of the results of Parsons and Drickamer shows evidence of a charge-transfer transition that is symmetry restricted, and made allowed by vibrational-electronic perturbations. A perturbation treatment is carried out that follows the method developed by Liehr and Ballhausen for the $d^n \rightarrow d^n$ crystal-field transitions, that are also symmetry forbidden. Finally, two types of experiments that would test the proposed explanations are described.

11369 EFFECT OF PRESSURE ON THE SPECTRA OF MnO_4^- AND CrO_4^{--}. W.H.Bentley and H.G.Drickamer.
J. chem. Phys. (USA), Vol. 34, No. 6, 2200 (June, 1961).

The intense absorption bands of solid $KMnO_4$ and K_2CrO_4 both show blue shifts of about equal amounts and approximately proportional to pressure for pressures up to 60 kilobars. This is consistent with the theoretical assignments of the bands to a transition from a non-bonding to an anti-bonding orbital.

G.F.Lothian

11370 TAYLOR SERIES EXPANSION OF THE INTERMEDIATE COUPLING ENERGY LEVELS OF Nd^{3+} AND Er^{3+}.
E.Y.Wong.
J. chem. Phys. (USA), Vol. 35, No. 2, 544-6 (Aug., 1961).

A Taylor series expansion of the intermediate coupling energy levels for Nd^{3+} and Er^{3+} was calculated. New energy levels can be calculated without rediagonalizing the matrix. A calculation for $NdCl_3$ is discussed as an example.

11371 ULTRAVIOLET ABSORPTION SPECTRA IN RUBY.
A.Linz, Jr and R.E.Newnham.
Phys. Rev. (USA), Vol. 123, No. 2, 500-1 (July 15, 1961).

The optical properties of highly doped rubies were investigated. Al_2O_3 and Cr_2O_3 form a complete solid-solution series; single crystals containing up to 5 mole % chromia were grown by the Verneuil technique. The optical absorption of a group of ultraviolet crystal-field bands near 3400 A was studied as a function of temperature, crystal orientation, and chemical composition. The intensity of these absorption bands varies with the square of the Cr concentration, perhaps indicating strong chromium-pair interactions.

11372 LATTICE ABSORPTION BANDS IN SiC.
L.Patrick and W.J.Choyke.
Phys. Rev. (USA), Vol. 123, No. 3, 813-15 (Aug. 1, 1961).

Using four phonon energies, TA = 0.045, LA = 0.067, TO = 0.0955, and LO = 0.1055 eV, it is possible to explain, as summation bands, the ten absorption bands lying in the energy range 0.130 to 0.300 eV. Phonon energies close to three of the four given here were obtained by an analysis of the indirect interband absorption in SiC.

11373 CRYSTAL SPECTRA OF METAL COORDINATION COMPOUNDS. V. THE FIVE-COORDINATED SALICYLALDEHYDE-ETHYLENEDIIMINE COPPER (II) COMPLEX.
J.Ferguson.
J. chem. Phys. (USA), Vol. 34, No. 6, 2206-7 (June, 1961).

For Pt IV see Abstr. 8987 of 1961. The absorption spectra of crystals of the above compound were examined with a reflecting microscope and a Hilger constant-deviation spectrometer. The three crystal faces, (100), (001) and (010) were used. [The crystal structure has been reported by Hall and Waters, Journal of the Chemical Society (GB), 2644 (1960); Pachler and Stackelberg, Zeitschift für anorganische und allgemeine Chemie (Germany), Vol. 305, 286 (1960)]. In solution the compound has a high intensity band at 17 900 cm^{-1} but the crystal spectrum is quite different and for light incident on the (100) face there are bands at 20 800 cm^{-1} and 17 300 cm^{-1}. The polarization of the bands is related to the molecular orientation and unlike other copper complexes, which have centres of symmetry, the bands are not of mixed molecular polarization but are strongly polarized in the mean molecular plane and there is no significant absorption normal to the plane. J.Iball

11374 ABSORPTION AND LUMINESCENCE OF IMPURITIES IN ORGANIC COMPOUND CRYSTALS AT 20°K. I. SPECTRA OF SOLUTIONS OF NAPHTHACENE IN DIBENZYL AND DIPHENYL CRYSTALS. A.F.Prÿkhot'ko and A.V.Soloviov.
Ukrayin. fiz. Zh. (USSR), Vol. 4, No. 1, 92-107 (1959). In Ukrainian.

Investigated, inter alia, the dependence of the spectra on the concentration of the impurity (from 0.01 to 1-2% by weight) for crystals varying in thickness from 1 to 100 μ. An electron—vibration analysis of the spectra was carried out. A possible cause of the complex structure is discussed.

11375 ABSORPTION AND LUMINESCENCE OF IMPURITIES IN ORGANIC COMPOUND CRYSTALS AT 20°K. II. SPECTRA OF NAPHTHACENE SOLUTIONS IN CRYSTALS OF CERTAIN UNCONDENSED AROMATIC HYDROCARBONS.
A.F.Prÿkhot'ko and A.V.Soloviov.
Ukrayin. fiz. Zh. (USSR), Vol. 4, No. 2, 229-38 (1959). In Ukrainian.

Investigated naphthacene impurities in tolan, stilbene and p-ditolyl crystals. Polarization of certain bands, particularly pronounced at high concentrations of naphthacene, was observed in the impurity absorption spectra in the given crystals.

11376 ABSORPTION AND LUMINESCENCE [SPECTRA] OF CRYSTALLINE SOLUTIONS OF STILBENE IN TOLAN AT 20°K. I.Ya.Fugol'.
Ukrayin. fiz. Zh. Dodatok (USSR), Vol. 3, No. 2, 40-8 (1958). In Ukrainian with summary (1 p.) in Russian.

Curves were obtained for the impurity absorption $\kappa(\nu)$ and intensity distribution in the luminescence spectrum. It was found that the stilbene molecules are arranged in the tolan crystal in the same way as in their own lattice. The impurity absorption spectra are compared with the absorption spectrum of a pure stilbene crystal. The variation of the impurity absorption and of the luminescence was studied. In the crystalline petals obtained by sublimation the same changes were noted in the frequency and intensity of the lines as those observed in spectra of crystals obtained on crystallization under pressure. Changes in the luminescence spectrum were observed in one and the same crystal on repeated heating and cooling.

11377 FAR-INFRARED BANDS OF SOME CRYSTALS WITH STRONG HYDROGEN BONDS. D.Hadži.
J. chem. Phys. (USA), Vol. 34, No. 4, 1445 (April, 1961).

Spectra in the 500–100 cm^{-1} region were obtained for seven compounds (including potassium, rubidium and ammonium dihydrogen phosphates) all containing very strong hydrogen bonds.

In five of the compounds bands due to direct transitions between the split zero vibrational levels of the OH oscillator were present. These bands, which do not appear in the deuterium analogues, support the theory that the splitting is due to proton tunnelling.

D.L.Greenaway

11378 IMPURITY INDUCED INFRARED LATTICE VIBRATION ABSORPTION. R.F.Wallis and A.A.Maradudin. Progr. theor. Phys. (Japan), Vol. 24, No. 5, 1055-77 (Nov., 1960).

Impurities are known to affect vibrational properties of crystals by modifying the distribution of normal mode frequencies and altering the nature of the atomic displacements in the neighbourhood of the impurities. The effects of isotopic impurities are calculated on the lattice vibrational optical absorption of both monatomic and diatomic linear chains of alternately charged particles. It is found that even with the harmonic approximation and the use of the cyclic boundary condition, the presence of impurities leads to a broad absorption of the low-frequency side of the main maximum. This is in contrast with the delta-function type of absorption at the optical frequency predicted by these models in the absence of impurities. For those cases in which discrete frequencies associated with localized vibrational modes occur, absorption at these isolated frequencies also occurs. This latter absorption can take place at frequencies higher than that of the main maximum. The relation between the results of these calculations and available experimental data is discussed.

11379 THE INFRARED REFLECTION SPECTRA OF BORON OXIDE AND FUSED QUARTZ AT HIGH TEMPERATURES. E.P.Markin and N.N.Sobolev. Optika i Spektrosk. (USSR), Vol. 9, No. 5, 587-92 (Nov., 1960). In Russian.

Reports a study of the infrared reflection spectra of B_2O_3 (between 21° and 1000°C) and of fused quartz (between -190° and 2000°C). The reflection spectrum of B_2O_3 was retained on melting. The most intense band of SiO_2 (8.9 μ at -190°C) was also retained throughout the temperature range indicated above. The bands were displaced towards lower frequencies on increase of temperature. These observations show that the main structural units of B_2O_3 and SiO_2 are retained on transition from vitreous to liquid state. [English translation in: Optics and Spectrosc. (USA), Vol. 9, No. 5, 309-12 (Nov., 1960)].

A.Tybulewicz

11380 ABSORPTION SPECTRA OF TRANSITION IONS IN CdS CRYSTALS. R.Pappalardo and R.E.Dietz. Phys. Rev. (USA), Vol. 123, No. 4, 1188-1203 (Aug. 15, 1961).

The low-temperature optical absorption spectra of single crystals of wurtzite CdS containing impurity ions of the first transition series and one rare-earth ion, ytterbium, were studied in the range of 4.5 to 0.4 μ. The main features of the spectra were found to be in good agreement with a cubic crystal field model, while structure found in the spectral bands of nickel and cobalt impurities could be described by a simple, first-order treatment using the free ion spin–orbit coupling constants. The relevant crystal field parameters, the site symmetry, and formal charges of the impurity ions were determined where possible.

11381 INFRARED SPECTRA OF NaOH ABOVE AND BELOW THE MELTING POINT. J.Greenberg and L.J.Hallgren. J. chem. Phys. (USA), Vol. 35, No. 1, 180-2 (July, 1961).

The absorption spectra of NaOH and mixtures of NaOH in $NaNO_3$, in $NaNO_2$ and in LiCl–KCl eutectic mixture were observed. The shift in the band position for NaOH as the temperature is varied is explained on the basis of hydrogen bonding in the melt.

11382 ABSORPTION AND DISPERSION OF LIGHT IN CERTAIN CRYSTALS OF THE POLYCYCLIC SERIES. M.S.Brodin and A.F.Prykhot'ko. Ukrayin fiz. Zh. (USSR), Vol. 3, No. 1, 79-87 (1958). In Ukrainian, with summary (1½ pp) in Russian.

Curves were obtained for the absorption and dispersion of light in stilbene crystals at 20.4°K and in tolan crystals at 293°K. A comparison is made between the experimental curve of dispersion in tolan and the theoretical curve calculated on the basis of the absorption spectra.

11383 SOLID-STATE VIBRATIONAL SPECTRA OF THE METHYL AND METHYL-d_3 HALIDES. M.E.Jacox and R.M.Hexter. J. chem. Phys. (USA), Vol. 35, No. 1, 183-8 (July, 1961).

The vibrational fundamentals of solid CH_3Cl, CH_3Br, and CH_3I and of their fully deuterated counter-parts were examined at 77°K under high resolution. CH_3Cl^{35} was synthesized and its ν_3 spectra compared to that of ordinary CH_3Cl, permitting the assignment the CH_3Cl^{135} and CH_3Cl^{37} contributions in the ν_3 multiplet structure. The relative intensities of absorption in 1:1 CH_3X:CD_3X solid solutions were measured to test the relationship between splitting, frequency, and absorption intensity predicted by the dipolar coupling model. The test proved to be insensitive. A study of the absorption of each component in CH_3Cl:CD_3Cl solid solutions throughout the concentration range showed that multiplet splitting persists at concentration as low as 1%.

11384 ABSORPTION OF POLARIZED LIGHT BY PYRENE AND CHRYSENE MONOCRYSTALS. V.V.Yeremenko. Ukrayin. fiz. Zh. Dodatok (USSR), Vol. 3, No. 2, 49-55 (1958). In Ukrainian.

Absorption spectra of these monocrystals, cooled to 20°K, were photographed in polarized light. The first electronic transition apparently possesses $A_{1g} \rightarrow B_{1u}$ symmetry in pyrene, and $A_g \rightarrow B$ symmetry in chrysene.

11385 THE EFFECT OF THE REFRACTIVE INDEX OF A SUBSTANCE ON THE TEMPERATURE DEPENDENCE OF THE RAMAN BAND INTENSITIES. T.P.Tulub and Ya.S.Bobovich. Optika i Spektrosk. (USSR), Vol. 9, No. 5, 669-70 (Nov., 1960). In Russian.

Reports a study of the temperature dependence of the Raman band intensities of sodium nitrate (290°-825°K), stilbene (290°-525°K), both of them in crystalline and molten states, of $ZnCl_2$ solutions in water (290°-370°K) and of trichloracetic acid solutions in water, dioxane and acetic acid (290°-370°K). The temperature dependence anomalies could be accounted for by variations of the refractive index of the substance (the solvent in the case of solutions) with temperature. [English translation in: Optics and Spectrosc. (USA), Vol. 9, No. 5, 352-3 (Nov., 1960)].

A.Tybulewicz

11386 SOME CONTRIBUTIONS TO THE X-RAY SPECTROSCOPY OF SOLID STATE.
I. X-RAY EMISSION SPECTRA.
II. THE FINE STRUCTURE OF X-RAY ABSORPTION SPECTRA OF VARIOUS SUBSTANCES.
III. THE THEORY OF THE FINE STRUCTURE OF THE X-RAY ABSORPTION SPECTRUM.
M.Sawada, K.Tsutsumi, T.Shiraiwa, T.Ishimura and M.Obashi. Annu. Rep. Sci. Works Fac. Sci. Osaka Univ., Vol. 7, 1-25, 25-64, 64-84 (1959).

Pt I describes experiments made to test the validities of the various theories on the existence of non-diagram, or satellite, lines. The studies reported are on the influence of the lattice binding in the K series of fluorine, the structures of the X-ray non-diagram lines for the elements from Cr to Zn, and the origin of the non-diagram lines of some iron-group compounds. The non-diagram lines of the Kα series of fluorine in a number of fluorine compounds were photographed. The wavelengths of the F Kα lines were measured with respect to reference lines on either side. A table is given for the various compounds of the F Kα wavelengths, their energy values, and energy separations of the non-diagram lines from the Kα_1 line. The asymmetry and presence of humps in the Kα lines was studied. It is shown that the bands observed for the F K$\alpha_{1,2}$ lines are due to transitions from the filled outer valence electron levels into a vacant K shell. The K$\alpha_{1,2}$ lines show a displacement depending on the nature of the metal atom in the compound. The non-diagram Kβ_η and Kβ_1 lines for elements from Cr to Zn were photographed. A table is given of wavelength and energy for the lines. Also listed are the experimentally measured energies, and the energies calculated on the basis of a two electron jump in a doubly ionized atom which obeys the Heisenberg selection rules. Non-diagram K$\alpha_{3,4}$ lines of metallic iron, and Kβ' lines from $Cr_2(SO_4)_3nH_2O$, Cr_2O_3, MnO_2, $MnSO_4H_2O$, $Fe(NH_4)_2(SO_4)_26H_2O$, and Fe_2O_3 were obtained by fluorescence. Extensive tables, photographs, and intensity traces of the results are given. The origins of the lines are discussed. In Pt II, the fine-structure of X-ray absorption spectra was studied for: Ni—amorphous As; Fe—S; amorphous Fe; amorphous Se; amorphous single-crystal Ge; Ni—Al; metallic Co; metallic Ti; rutile and anatase forms of TiO_2; n-butyl polytitanate; Fe—Ni alloy; Co—Ni alloy; nickel oxides; Fe, Ni, Cu, and Zn phthalocyanines; liquid Ga. The fine-structures of the absorption edges are given, and in many cases the change of electrical resistance with temperature. Radius of gyration of the amorphous state particles are quoted. The variations of the fine-structure absorption coefficients with specimen

less were investigated for metallic Cu, $CuCl_2 2H_2O$, $CuSO_4 5H_2O$, $oCl_2 6H_2O$. In Pt III, a theory is given for the fine-structure K absorption edge, and applied to Cu, Ni, Fe, Ti, rutile and se. The calculated results are compared with those measured imentally, and found to be in good agreement especially for ase of the metals. 130 references are given. R.V.Coates

11387 ASYMMETRY OF THE $K_{\alpha_{12}}$ LINES OF ZINC IN ITS SEMICONDUCTING COMPOUNDS WITH ANTIMONY.
apshukov and Ya.A.Ugai.
tverdogo Tela (USSR), Vol. 3, No. 1, 100-2 (Jan., 1961).
ussian.

The asymmetry indices and the relative widths of the K_{α_1} a K_{α_2} lines of zinc in the semiconducting compounds ZnSb, Sb_2 and $Zn_4 Sb_3$ were measured and compared with the corres- ling values in the cases of ZnS, ZnO and Zn. The table showing results also includes the two asymmetry indices of the same s for pure Cu. The symmetry found in the cases of ZnS, ZnO Zn can be explained on the assumption that only the 4s-electrons n are concerned in the formation of chemical bonds in these stances. The asymmetry found in the lines of the three zinc- mony compounds is connected with the part played by the electrons of the zinc in the formation of chemical bonds with mony. The width of the lines undergoes little change on passing n one zinc compound to another. [English translation in: Soviet sics–Solid State (USA), Vol. 3, No. 1, 73-4 (July, 1961)].
N.Davy

11388 A STUDY OF THE CHARACTERISTIC ABSORPTION OF X-RAYS IN BINARY ALLOYS OF IRON WITH NICKEL, BALT AND CHROMIUM. L.H.Nikolayeva and S.M.Karal'nyk.
ayin. fiz. Zh. (USSR), Vol. 4, No. 2, 260-7 (1959). In Ukrainian.
A study was made of the change in position in the energy scale he K absorption edge. It was established that the maximum nges in the K-edge position occur (approximately) in the concen- tion regions where extremal values of other physical properties e noted. An attempt is made to interpret the results by taking o consideration the changes in external screening during change in nature of the interatomic bond. A possible connection is erred between Kunzel's rules for X-ray spectra and Wagerd's es for change in the lattice parameter during alloying. Considera- n is given as to the state of iron and chromium atoms on being oyed in the σ-phase state.

11389 STUDY OF TEMPERATURE VARIATIONS OF THE INTENSITY OF LIGHT SCATTERED BY A SINGLE RYSTAL OF SODIUM CHLORATE. L.Taurel and G.Fontaine.
R. Acad. Sci. (France), Vol. 252, No. 13, 1934-6 (March 27, 1961).
French.
After a few thermal cycles (20°-100°C) the scattered intensity creases linearly and reversibly with increasing temperature, as eviously found for quartz (see Abstr. 11619 of 1960). The versible part of the scatter is greater than expected for a perfect ystal and the excess is attributed to lattice faults. G.F.Lothian

uminescence

11390 STIMULATED OPTICAL EMISSION IN FLUORESCENT SOLIDS. I. THEORETICAL CONSIDERATIONS.
.H.Maiman.
hys. Rev. (USA), Vol. 123, No. 4, 1145-50 (Aug. 15, 1961).
An analysis of stimulated emission processes in fluorescent olids is presented. The kinetic equations are discussed and xpressions for pumping power and effective temperature of the xciting source are given in terms of the material parameters. A omparison of excitation intensity for three- and four-level systems s given. The spectral width of the stimulated radiation is discussed ith particular attention to imperfect crystals.

11391 STIMULATED OPTICAL EMISSION IN FLUORESCENT SOLIDS. II. SPECTROSCOPY AND STIMULATED EMISSION IN RUBY.
T.H.Maiman, R.H.Hoskins, I.J.D'Haenens, C.K.Asawa and V.Evtuhov.
Phys. Rev. (USA), Vol. 123, No. 4, 1151-7 (Aug. 15, 1961).
Optical absorption cross-sections and the fluorescent quantum efficiency in ruby were determined. The data were used to correlate calculations with the analysis of the preceding paper (Pt I, see preceding abstract). Stimulated emission from ruby under pulsed excitation was studied in some detail; the observations are found to depend strongly on the perfection of the particular crystal under study. A peak power output of approximately 5 kW, total output energy of near 1 joule, beam collimation of less than 10^{-2} rad, and a spectral width of individual components in the output radiation of about 6×10^{-4} A at 6943 A were obtained. It is suggested that mode instabilities due to temperature shifts and a time-varying magnetic field are contributing to an oscillatory behaviour of the output pulse.

11392 DECAY OF PHOSPHORESCENCE FROM A DISTRIBUTION OF TRAPPING LEVELS. W.L.Medlin.
Phys. Rev. (USA), Vol. 123, No. 2, 502-9 (July 15, 1961).
In a previous paper it was shown that the usual model for second-order decay predicted the correct form for the decay in many thermoluminescent crystals but gave the wrong behaviour for the parameters involved. Specifically, it was shown that b and m in the decay expression, $I = I_0[b/(b + t)]^m$, should behave differently as functions of the decay temperature and the degree of trap filling than is observed experimentally at temperatures near or below the glow peak. In the present paper it is shown that the discrepancies can be accounted for by assuming a first-order decay from a distribution of trapping levels. Most of the results are based on a Gaussian distribution but it is shown that other distributions can produce similar results. The first-order mechanism is justified by considering the relative magnitudes of the rate constants for trap emptying, retrapping, and recombination. At temperatures well above the glow peak this assumption is no longer justified, but in this range the second-order decay predicts the observed results for b and m. The effects of retrapping and of crystal dimensions are considered. Also, the effect on the glow peak of having a distribution of levels rather than a set of discrete levels is worked out and it is shown that the peak is broadened appreciably even for relatively narrow distributions.

11393 INFRARED LUMINESCENCE OF F-CENTRES IN ALKALI HALIDE CRYSTALS. I.I.Yezhyk.
Ukrayin. fiz. Zh. Dodatok (USSR), Vol. 3, No. 2, 56-63 (1958).
In Ukrainian, with summary (1 p.) in Russian.
The spectrophotometric method was employed at liquid nitrogen temperature to determine the maximum ion emission bands (at 1.15, 1.00 and 1.31 μ, respectively) of X-irradiated NaCl, KCl and KBr crystals. At room temperatures these maxima shift towards the long-wave region (by 0.02–0.03 μ). The infrared fluorescence damping curves are defined by the exponents. The rate of infrared fluorescence damping is considerably lower at 77°K than it is at room temperature. To explain the damping and the mechanism of the appearance of infrared luminescence in the region between 0.9 and 1.5 μ, a kinetic diagram is presented in which the F-centre is represented by means of two levels — the basic K and the excited i. The absorption of a light quantum in the F-centre leads to the electron passing into an excited state (on the i level). The transition of the excited electron into the basic state K, i.e. the 1s state, is accompanied by infrared emission. This process may be repeated many times, until the electron is forced into the conduction band by the thermal fluctuation while being in an excited state. The infrared emission is considerably prolonged in time because of repeated transitions of electrons in the F-centre.

FLUORESCENCE OF OXYGEN IN ALKALI HALIDE CRYSTALS.
See Abstr. 11363

11394 LOW TEMPERATURE LUMINESCENCE AND ABSORPTION IN CRYSTALS OF BiI_3. R.I.Shekhmamet'ev.
Fiz. tverdogo Tela (USSR), Vol. 3, No. 2, 581-4 (Feb., 1961).
In Russian.
For abstract, see Abstr. 10111 of 1961. [English translation in: Soviet Physics—Solid State (USA), Vol. 3, No. 2, 426-8 (1961)].

11395 ION DETERIORATION OF LUMINESCENCE IN INORGANIC PHOSPHORS. R.Grasser and A.Scharmann.
Z. Naturforsch. (Germany), Vol. 16a, No. 1, 10-12 (Jan., 1961).
In German.
The deterioration of luminescence of cadmium tungstate, calcium halophosphate and boron nitride due to ion bombardment was investigated as a function of mass and energy of the bombarding ions. Excitation of luminescence in bombarded phosphors with the ions or with ultraviolet light gives an increase in deterioration with ionic mass. For light ions a decrease of damage occurs with increase in ion energy but the reverse occurs for heavy ions. The results are interpreted by use of Seitz's theory of damage in solids.
G.F.J.Garlick

PA4

11396 THE EFFECT OF TEMPERATURE ON TWO SERIES OF BANDS IN THE GREEN FLUORESCENCE SPECTRUM OF PURE CADMIUM SULPHIDE AT LOW TEMPERATURES.
M.Bansi-Griio [Bancie-Grillot], E.F.Gross, E.Griio [Grillot] and B.S.Razbirin.
Optika i Spektrosk. (USSR), Vol. 9, No. 4, 542-4 (Oct., 1960). In Russian.

Very pure CdS, which does not luminesce at room temperature, exhibits intense green fluorescence at the temperature of liquid air. The spectrum of this fluorescence consists of two vibrational series whose maxima are given by $\nu_1 = 19\,450 - 300n$ and $\nu_2 = 19\,310 - 300p\ cm^{-1}$, where n and p are small integers. The present paper reports further studies on the effect of temperature and 1 kV/cm electric field on the relative intensities of the two series between 4° and 77°K. [English translation in: Optics and Spectrosc. (USA), Vol. 9, No. 4, 287-8 (Oct., 1960)]. A.Tybulewicz

11397 FLUORESCENCE AND OPTICAL MASER EFFECTS IN $CaF_2:Sm^{++}$. W.Kaiser, C.G.B.Garrett and D.L.Wood.
Phys. Rev. (USA), Vol. 123, No. 3, 766-76 (Aug. 1, 1961).

Measurements are reported of absorption, emission, and activation spectra in $CaF_2:Sm^{++}$, and also of fluorescence lifetime. A revised level scheme is proposed. Observations of optical maser effects were made at liquid-hydrogen and liquid-helium temperatures over a wide range of pumping intensities. For illumination in the 6400 A band, the threshold intensity of illumination was about 20 W/cm². Observations are reported of the dependence of the intensity of the maser beam on the pumping intensity. Photographic observations, made both with or without a Fabry–Perot etalon, show that on one particular sample five distinct frequencies were present in the maser signal, and that the number of modes excited was of the order of 1000.

11398 SINGLE-CRYSTAL MOLYBDATES FOR RESONANCE AND EMISSION STUDIES.
G.Van Uitert, F.W.Swanekamp and S.Preziosi.
J. appl. Phys. (USA), Vol. 32, No. 6, 1176 (June, 1961).

Incorporations of rare-earths or transition metal ions and their effects on optical properties are discussed; some experimental details are given. H.E.Schmid

11399 APPROXIMATE CALCULATION OF REABSORPTION IN THE EQUATION OF EXCITON DIFFUSION.
O.M.Faidysh and L.Yu.Chechik.
Ukrayin. fiz. Zh. (USSR), Vol. 3, No. 5, 587-94 (1958). In Ukrainian, with summary (1 p.) in Russian.

The theory of diffuse motion of excitons in organic crystals, advanced by Kucherov and Faidysh (1956), has made it possible to give a correct interpretation of a number of phenomena caused by the migration of electron excitation energy. In its original form this theory did not take into consideration the effect of reabsorption on the transfer of electron excitation energy from the host substance to the impurity. The present paper gives an approximate calculation of the effect of reabsorption on the quantity and space distribution of excitons and on the quantum yields of luminescence. As a result of reabsorption, the quantum yield of luminescence of the impurity increases, according to the calculations made, by a factor of 1.81 for $c_n = 0$, by a factor of 1.71 for $c_n = 10^{-6}$, of 1.36 for $c_n = 10^{-5}$, of 1.05 for $c_n = 10^{-4}$, of 1.04 for $c_n = 2 \times 10^{-4}$ (where c_n is the impurity concentration in mol/mol). The quantum yield of luminescence of the host substance (in the case of anthracene crystals) decreases because of reabsorption by a factor of 0.96 for $c_n = 0$, of 0.91 for $c_n = 10^{-6}$, of 0.78 for $c_n = 10^{-5}$, of 0.70 for $c_n = 10^{-4}$, of 0.70 for $c_n = 2 \times 10^{-4}$. The values obtained approximately agree with the experimental results.

11400 PHOSPHORESCENCE SPECTRA OF ACENAPHTHENE AT LOW TEMPERATURES. A.Zmerli.
J. chem. Phys. (USA), Vol. 34, No. 6, 2130-5 (June, 1961).

The phosphorescence spectra of acenaphthene, both of single crystals and of solutions in different solvents (polystyrolene, benzene, or E.P.A.), were photographed at low temperatures. At 4° and 77°K unpolarized spectra of the crystal were obtained using a phosphoroscope, and at 20°K the polarized spectra along the three crystallographic axes were photographed without the phosphoroscope. Some peculiarities linked to the existence of two different sets of molecules in the unit cell were observed. Two progressions, here called "normal" connected to each set of molecules were distinguised in the 4° and 77°K spectra but not in the 20°K spectrum. The interval between the corresponding bands of the two progressions is 28 cm^{-1}. In the 20°K spectrum two new series, here called "nonnormal", and which appear also in the 77°K spectrum were observed. An attempt at interpretation of these "nonnormal" series is given.

LUMINESCENCE OF STILBENE–TOLAN CRYSTALS.
See Abstr. 11376

11401 EFFECTS OF RARE-EARTH SUBSTITUTIONS ON THE FLUORESCENCE OF TERBIUM HEXA-ANTIPYRIN TRI-IODIDE. R.R.Soden.
J. appl. Phys. (USA), Vol. 32, No. 4, 750-1 (April, 1961).

Specimens were prepared having gadolinium, yttrium, dysprosium and erbium as the substitutional rare earths. These were present with Tb in concentrations varying from 10^{-6} to 1 of the rare-earth content. The specimens were then irradiated with 2537 A light and the intensity of the emission at 5490 A observed as a function of the substitutional rare-earth concentration. Under gradient on a log–log plot, which would be expected if each rare earth hexa-antipyrene aggregate had equal probability of absorbing and emitting energy, was observed for only the dysprosium–terbium complex down to a ratio of one part Tb to 1000 Dy. At this concentration the intensity becomes practically constant due to the development of a weak broadband fluorescence. The results for the other three rare-earths used with Tb are explained in terms of energy transfer between the different rare-earth complexes. In the cases of Gd and Y, the fluorescence change with concentration is such that a fluorescence intensity study could be used to determine the relative concentration of Tb in high-purity gadolinium or yttrium source materials. L.Ca

11402 ON THE VOLTAGE DEPENDENCE OF CATHODOLUMINESCENCE. G.Gergely.
Acta tech. Hungar., Vol. 33, No. 1-2, 135-41 (1961).

A qualitative explanation of the cathodoluminescence brightness versus voltage curve is given by assuming surface recombination and diffusion of released internal secondaries (electrons and holes). The thickness of the dead surface layer of crystals is of the same magnitude as the diffusion length of internal secondaries. Young's law was used in the calculations. The value of the diffusion length of secondaries is between 0.05 and 1.1 μ.

11403 THE LUMINOUS EMISSION OF CADMIUM SULPHIDE BOMBARDED BY CATHODE RAYS.
F.Bombré and F.Gans.
C. R. Acad. Sci. (Paris), Vol. 252, No. 15, 2209-11 (April 10, 19
In French.

Powder screens of CdS give a red emission band, peak 7200 and also a green band which is more prominent with purer samples (or with a single crystal). With increase of beam current the proportion of green emission increases, and its peak moves from 5100 to 5400A. At high current densities a new band appears at 6050A. The green emission is due to transitions between valence and conduction bands. S.T.Hender

11404 INTERPRETATION OF EXCITON INDUCED LUMINESCENCE IN KI:Tl. M.Tomura.
J. Phys. Soc. Japan, Vol. 15, No. 8, 1508-16 (Aug., 1960).

It is pointed out that the absorption coefficient at the long wavelength tail of the first characteristic absorption band of a single crystal of KI is much smaller than that of an evaporated polycrystalline film of KI, and the complex shapes of excitation spectra of the exciton induced luminescence from Tl^+ ion and a certain impurity are explained. Furthermore, a new weak absorption band is found in the long wavelength tail of the first exciton absorption band, which is infered to be due to the triplet-like state of the exciton. Some discussions are given on the problem of migration of excitons and the life time of the exciton is estimated to be much longer than 10^{-9} sec.

11405 ON THE EHRENBERG–FRANKS EXPERIMENT RELATING TO THE PENETRATION OF ELECTRONS INTO LUMINESCENT MATERIAL. G.Gergely.
Proc. Phys. Soc. (GB), Vol. 76, Pt 3, 437 (Sept. 1, 1960).

The constant d in the range–voltage formula $R = V^2/c + d$ of Ehrenberg and Franks (Abstr. 1198 of 1954) is interpreted as due to the ambipolar diffusion of secondary electrons and holes, the diffusion length being estimated as 0.05 - 0.1 μ from the voltage dependence of cathodoluminescence. G.F.J.Gar

406 AN ATTEMPT TO INTERPRET THE SCINTILLATION EFFECTS IN THIN POLYCRYSTALLINE FILMS.
velli, M.Teboul and C.Uny.
. Acad. Sci. (France), Vol. 252, No. 14, 2075-7 (April 5, 1961).
ench.
The scintillations observed previously [Abstr. 15921 of 1960, bid., Vol. 248, No. 11, 1665 (March 16, 1959)] can be explained ssuming that the film contains metal-semiconductor contacts ain boundaries. C.Hilsum

1407 ELECTROLUMINESCENCE AT P-N JUNCTIONS IN GALLIUM PHOSPHIDE.
ershenzon and R.M.Mikulyak.
ppl. Phys. (USA), Vol. 32, No. 7, 1338–48 (July, 1961).
Both diffused and alloyed junctions were prepared from single stals of GaP cut from ingots grown near the melting point, as as from crystals grown at lower temperatures. The diodes e characterized by their current—voltage relationship and their acity at reverse bias. Anomalies in both the forward and the erse currents, an excess capacity, and a hysteresis effect are ibuted to the presence of deep centres in the depletion layer, ticularly in the alloyed structures. A nearly compensated layer found at the junction of the diffused diodes. The spectra, bias endences, decay times, and efficiencies of the electroluminescence tted at these junctions at both forward and reverse bias were lied and correlated with the diode models. At reverse bias, iative intraband relaxation was due to carriers excited during lanche breakdown (diffused diodes), by internal field emission oyed diodes), and from carriers thermally generated within the letion layer (all diodes). At forward bias, only the diffused ctions exhibited light emission and this was of two types: (1) a d-to-band recombination with phonon cooperation, whose recom- ation kinetics depended on whether or not the process occurred h the depletion layer, and (2) recombination through a deep level ich may be associated perhaps with a vacancy.

ELECTROLUMINESCENT PROPERTIES OF ZnS.
e Abstr. 11330

11408 NON-ISOTHERMAL RELAXATION OF LUMINESCENCE SPECTRA OF X-RAY IRRADIATED KCl YSTALS ACTIVATED WITH Tl^+, In^+, Ag^+ AND Cu^+ IONS.
.Vitol.
ika i Spektrosk. (USSR), Vol. 9, No. 4, 535-8 (Oct., 1960).
Russian.
Reports a study of thermoluminescence spectra of KCl crystals taining Tl^+, In^+, Cu^+, Ag^+, Pb^{++} and Sn^{++} ions. The rate of ting was 0.1-0.3 deg sec^{-1}. Thermoluminescence of KCl:Tl sisted of two bands (due to electronic-vibrational transitions in ions). The ratio of the band intensities was strongly affected rise of temperature (partly due to temperature quenching). l crystals activated with In^+, Cu^+ and Ag^+ also had thermo- inescence bands due to electronic transitions in the activator s. Thermoluminescence of KCl:Pb and KCl:Sn was at least 00 times weaker than that of KCl:Tl; such weak emission lay low the sensitivity threshold of the author's apparatus. A non- tivator band was observed at 440 mμ in all phosphors. [English nslation in: Optics and Spectrosc. (USA), Vol. 9, No. 4, 282-3 ct., 1960)]. A.Tybulewicz

11409 EFFECT OF α-PARTICLES ON ZINC AND SULPHIDE PHOSPHORS. N.Riehl, R.Sizmann and O.J.Stadler.
Naturforsch. (Germany), Vol. 16a, No. 1, 13-20 (Jan., 1961).
Germ an.
The changes in thermoluminescence and luminescence spectra ZnS and ZnO phosphors due to α-particle bombardment were easured. No new peaks were found in glow curves after bombard- ent. After prolonged bombardment deep traps were created hich function as quenching centres. ZnS:Cu phosphors develop a lue emission band on bombardment which is related to the creation f cation vacancies. G.F.J.Garlick

MAGNETIC PROPERTIES OF SOLIDS

11410 A POSSIBILITY OF AN EXPERIMENTAL SEPARATION OF THE PARA- AND DIA-MAGNETISM OF CONDUCTION ELECTRONS. E.Fick and H.J.Mikeska.
Z. Naturforsch. (Germany), Vol. 16a, No. 4, 435-6 (April, 1961).
In German.
If, by means of some high frequency radiation, it is possible to keep the spin temperature T_S different from the translational temperature T_O, it may be proved that the spin susceptibility is no longer temperature independent, but is proportional to T_O/T_S. By varying the ratio T_O/T_S it appears thus possible to determine separately the paramagnetic and diamagnetic contributions to the total susceptibility of the conduction electrons. L.Pincherle

11411 THE DE HAAS- VAN ALPHEN EFFECT AND COULOMB INTERACTION. H.Ichimura and S.Tanaka.
Progr. theor. Phys. (Japan), Vol. 24, No. 2, 457-9 (Aug., 1960).
Calculates the phase shift as affected by the exchange interactions. E.P.Wohlfarth

DIFFERENTIAL PARAMAGNETIC EFFECT IN SUPERCONDUCTORS. See Abstr. 10640

11412 MAGNETIC PROPERTIES OF URANIUM TETRAFLUORIDE.
M.J.M.Leask, D.W.Osborne and W.P.Wolf.
J. chem. Phys. (USA), Vol. 34, No. 6, 2090-9 (June, 1961).
The magnetic susceptibility of a number of UF_4 samples was measured in the temperature range 1.3°-20.4°K, using the mutual inductance method of McKim and Wolf. Although some of the samples were highly purified, initial measurements indicated appreciable differences between their susceptibilities below 4.2°K. These differences were eventually overcome by subjecting the specimens to the same heat treatment just before susceptibility measurement. The effect of the heat treatment is not entirely understood, but a number of possibilities were investigated. Theoretically, the main features of the susceptibility variation are explained on a simple crystal field model of noninteracting ions, and this also accounts for the recent specific heat measurements of Burns, Osborne, and Westrum. An even better theoretical fit is obtained by introducing a small, adjustable interaction between neighbouring uranium ions. Below 2°K the measured susceptibility was anomalous: Samples which at higher temperatures were very similar (± 1%), showed considerable differences (~25%), the susceptibility in some cases increasing rapidly with decreasing temperature, and becoming dependent on measuring field. This behaviour is unexplained but it is probably not a property of "pure" UF_4.

11413 MAGNETIC PROPERTIES OF $HCrO_2$ AND $DCrO_2$.
R.G.Meisenheimer and J.D.Swalen.
Phys. Rev. (USA), Vol. 123, No. 3, 831-4 (Aug. 1, 1961).
Magnetic susceptibility measurements and electron paramagnetic resonance measurements were made on powdered chromous acid ($HCrO_2$) and deuterated chromous acid ($DCrO_2$). The Curie constants, derived from the susceptibility results, are consistent with three unpaired electrons associated with each chromium ion. In addition, a large Curie—Weiss θ temperature, indicating a strong exchange interaction, is necessary to account for the results. The most unusual feature of this particular exchange is that it is strongly influenced by deuteration. The electron paramagnetic resonance spectra also show strongly exchange-narrowed lines with a variation between $HCrO_2$ and $DCrO_2$. From a comparison between the calculated and observed linewidths and second moments, a value of the zero-field splitting is estimated. Although no transition has been observed to an antiferromagnetic state, the Curie—Weiss θ temperatures indicate that the ground state is undoubtedly antiferromagnetic for both $HCrO_2$ and $DCrO_2$. Superexchange through the intervening proton or deuteron is probably the main source of any antiferromagnetic exchange coupling. Some of the various mechanisms proposed for superexchange are discussed in relation to chromous acid.

11414 ADIABATIC DEMAGNETIZATION WITH YTTRIUM—RARE EARTH ALLOYS. D.T.Nelson and S.Legvold.
Phys. Rev. (USA), Vol. 123, No. 1, 80-4 (July 1, 1961).
Alloys of yttrium with 0.3 and 1.0 at.% gadolinium, 1.0 at.%

dysprosium, and 0.6 and 1.0 at.% holmium were investigated to determine their usefulness as the working substance for adiabatic demagnetization. In addition, single crystals of 0.6 and 1.0 at.% holmium–yttrium alloys were studied. Those alloys which exhibited paramagnetic susceptibility behaviour in the temperature range 1.2-4.2°K were demagnetized adiabatically from about 11 kOe and 1.25°K. The lowest temperature attained was 0.76°K for the single crystal of 1.0 at.% holmium with the magnetic field parallel to the a-axis of the hexagonal crystal. Magnetization measurements obtained for the single crystals in the temperature range 1.2-4.2°K indicated strong anisotropy with the a-axis as the easy axis of magnetization. Hysteresis was observed in the magnetization of the 1.0 at.% holmium single crystal with the a-axis parallel to the field. Entropy removal during magnetization was calculated from the magnetization data for the single crystals and found to be only about 15% of that expected if the alloy behaved like an ideal paramagnetic substance.

11415 MAGNETIC COOLING WITH PARAMAGNETIC METALS. R.D.Parks and W.A.Little.
Phys. Rev. Letters (USA), Vol. 6, No. 10, 539-41 (May 15, 1961).

Alloys of thorium with 1-10% erbium were cooled from 0.73°K to 0.1-0.2°K by removing a field of 8 kG. The spin entropy per cm^3 is comparable with that of paramagnetic salts, but the thermal conductivity much higher. Specific heat measurements are also reported. R.G.Chambers

11416 ON THE STATISTICS OF SPIN WAVES BY THE BETHE METHOD. B.Fechner.
Acta phys. Polon. (Poland), Vol. 19, No. 3, 289-93 (1960).

The exact solution of Slater–Bloch's secular equations by the Bethe method without any additional conditions is considered. The bearing of the results upon the question of statistics of spin waves is discussed. It is shown, that there exists an ambiguity which cannot be overcome without additional assumption.

11417 SPIN WAVES IN FERROMAGNETS AND ANTIFERROMAGNETS. II.
A.I.Akhiezer, V.G.Bar'yakhtar and M.I.Kaganov.
Uspekhi fiz. Nauk (USSR), Vol. 72, No. 1, 3-32 (Sept., 1960). In Russian.

For Pt I see Abstr. 7739 of 1961. Discusses the interaction of spin waves with spin waves and with phonons, the relaxation of the magnetic moment, the dispersion of the permeability and the thermal conductivity. [English translation in: Soviet Physics – Uspekhi (USA), Vol. 3, No. 5, 661-76 (March-April, 1961)]. E.P.Wohlfarth

11418 ON THE THEORY OF HEISENBERG'S MODEL OF A FERROMAGNETIC WITH SEVERAL ELECTRONS PER LATTICE SITE. Yu.A.Izyumov and E.N.Yakovlev.
Fiz. Metallov i Metallovedenie (USSR), Vol. 9, No. 5, 667-72 (May, 1960). In Russian.

The theoretical method of retarded and accelerated Green functions in statistical physics is used to calculate the energy spectrum of the elementary excitations and the intensity of magnetization for a Heisenberg model with more than two electrons per lattice site. It was shown that, in addition to spin waves, the energy spectrum of excitations in such a system also contains high energy branches of the Bose type, corresponding to optical vibrations in solids. M.H.Sloboda

11419 SYMMETRICAL PROPERTIES OF TWO-DIMENSIONAL ISING LATTICES. I.Syozi and S.Naya.
Progr. theor. Phys. (Japan), Vol. 24, No. 4, 829-39 (Oct., 1960).

Some symmetrical properties on the statistics of two-dimensional Ising lattices are studied. It is shown that such considerations provide very useful suggestions even for cases in which no exact solution is known. The cases of the square, triangular, honeycomb and generalized square lattices are especially studied with respect to the expressions for spontaneous magnetization and susceptibility.

11420 INDIRECT EXCHANGE MODEL FOR FERROMAGNETIC METALS. S.H.Liu.
Phys. Rev. (USA), Vol. 123, No. 2, 470-4 (July 15, 1961).

The ferromagnetic properties of rare-earth metals and their alloys are discussed in terms of the indirect exchange model. It is shown by the molecular-field approximation that, in calculating the Curie temperatures of these metals, the simple theory of Fröhlich and Nabarro (Abstr. 4616 of 1951; Abstr. 8521 of 1951) and Zener (1940) is applicable. The second-order energy terms calculated by Ruderman and Kittel (Abstr. 11330 of 1954) Kasuya (Abstr. 7209 of 1957) and Yosida (Abstr. 7220 of 1957) are important in discussi the low-temperature properties. Some numerical results are o tained which are in good agreement with the experiments.

11421 REMANENT STATE IN ONE-DIMENSIONAL MICROMAGNETICS. A.Aharoni.
Phys. Rev. (USA), Vol. 123, No. 3, 732-6 (Aug. 1, 1961).

A first integral is found for Brown's nonlinear equations in dimension. When the external field is zero, another first integr can be found, which enables complete integration of the equation For a unidirectional anisotropy with an easy direction perpendic to the plane of the film, one of the integration constants is not de mined by the boundary conditions, as if indicating a possibility o continuum of different remanence values for different histories. However, when a small field in the plane of the film is introduce a perturbation, this degeneracy is removed, and the magnetizatio can change only in the plane defined by the field and the directio of anisotropy. There are still many discrete possible values for remanence, each of which determines uniquely the susceptibility that state.

11422 IMAGE OF THE FERMI SURFACE IN SPIN-WAVE SPECTRA OF RARE-EARTH METALS.
E.J.Woll, Jr and S.J.Nettel.
Phys. Rev. (USA), Vol. 123, No. 3, 796-9 (Aug. 1, 1961).

Calculations of spin-wave spectra in rare-earth metals wer carried out to find whether images of the electronic Fermi surfa might be observable. In the space of spin-wave vectors $\vec{q}$ there should occur surfaces on which the frequencies have an infinite gradient with respect to $\vec{q}$, the location of such abrupt changes, "kinks" in the dispersion curves, being determined by the shape the Fermi surface. The spin-wave spectrum is found by assumi that the coupling between ionic spins takes place primarily throu exchange scattering of conduction electrons, paralleling the calc tion on the coupling of nuclear spins by Ruderman and Kittel. Sp wave dispersion curves in two directions of high symmetry are computed numerically. The sought-for kinks in the dispersion curves are found to amount to about 2% of the maximum excitatio frequency. The development is for ferromagnets, but extension spiral antiferromagnets is taken up briefly.

11423 SPIN CONFIGURATION AND MAGNETIZATION IN DYSPROSIUM. U.Enz.
Physica (Netherlands), Vol. 26, No. 9, 698-9 (Sept., 1960).

The magnetic properties of dysprosium single crystals are considered in terms of a model of ferromagnetic spin alignment the basal plane of the hexagonal crystal structure and of helical ordering in the perpendicular direction. Available experimental results are consistent with this model, and the angle between adjacent spins along the helical chain is roughly estimated as 12° R.Par

11424 MAGNETIC STUDIES OF ALLOYS OF THE CHROMIUM–GERMANIUM SYSTEM.
S.D.Margolin and I.G.Fakidov.
Fiz. Metallov i Metallovedenie (USSR), Vol. 9, No. 6, 823-7 (June, 1960). In Russian.

The microstructure of Cr–Ge alloys containing 50-95 at.% G was examined, and their magnetic susceptibility and intensity of magnetization in fields ≤ 16 000 Oe were measured at 75°-320°K. The results indicated that the alloys studied are ferromagnetic at 77°-110°K (with the Curie point being at 100°-110°K) and conta only one ferromagnetic phase whose composition probably corresponds to $CrGe_2$. M.H.Slob

11425 FIXING OF MAGNETIC MOMENT OF FERROMAGNE FINE PRECIPITATES IN Cu–Co ALLOY DURING AGING. K.Kabayashi.
J. Phys. Soc. Japan, Vol. 15, No. 7, 1352-3 (July, 1960).

Reports curves of total, remament and reversible magnetiza as a function of annealing time at 750°C in a field of 50 Oe, of a specimen of an alloy of 2% Co, 98% Cu. The alloy is non-ferro-magnetic initially and the magnetization develops mainly in a period 5 to 200 minutes after commencement of the heat treatme as a result of precipitation of cobalt. Field dependence of the maximum intensities of super-paramagnetism and of remament magnetization indicate that saturation is approached in fields of about 100 Oe. R.Par

11426 FERROMAGNETIC NUCLEATION SOURCES ON IRO WHISKERS. R.W.De Blois.
J. appl. Phys. (USA), Vol. 32, No. 8, 1561-63 (Aug., 1961).

Previous experimental work (see Abstr. 3031 of 1960) has

ablished that the near perfection of some selected iron whiskers ngs the axial magnetic field required to nucleate the reversal of gnetization close to the theoretical coercive force limit of M_s (560 Oe at 20°). Further experiments now show an approxitely constant shift of the nucleation-field contour along an n whisker with change in temperature, increases in nucleation d of several hundred oersteds along the lengths and at the tips several iron whiskers following electropolishing, and a correla- between observed microscopic surface imperfections and regions nucleation-field minima. These results support current ideas t abrupt surface contour variations are primarily responsible for lucing the observed nucleation fields for iron whiskers to below ideal value.

11427 INVESTIGATIONS ON ROTATIONAL HYSTERESIS. V.Zehler.
angew. Phys. (Germany), Vol. 13, No. 3, 139-41 (March, 1961). German.

Ferromagnetism Working Party, Wiesbaden, 1960 (see Abstr. 36 of 1961). The internal field and induction in a cylinder of nico were measured as it was rotated in a homogeneous external eld. The rotational hysteresis work obtained from this agrees th that determined directly from the measurement of the torque ting on the cylinder. D.S.Parasnis

11428 STATISTICAL ANALYSIS OF FERROMAGNETIC HYSTERESIS. H.Girke.
. angew. Phys. (Germany), Vol. 13, No. 5, 251-4 (May, 1961). German.

Discusses, on the basis of the Preisach model, the magnetiza- on-dependent interaction effects and the Barkhausen discontinuities some high-permeability magnetic materials. E.P.Wohlfarth

11429 CHANGE IN THE COERCIVE FORCE DURING CYCLIC HEAT TREATMENT ABOVE AND BELOW THE URIE POINT AND ITS CONNECTION WITH DISLOCATION TRUCTURE. I.Y.Dekhtyar and E.H.Madatova.
krayin. fiz. Zh. (USSR), Vol. 3, No. 5, 659-63 (1958). In Ukrainian, ith summary (1 p.) in Russian.

The effect was studied of cyclic heat treatment on the coercive rce H_c in a Fe + 8 at. per cent Al alloy. The results permit one draw the conclusions that multiple quenching, beginning at a mperature below the Curie point, causes a gradual increase in c. The coercive force is practically constant if the quenching is arried out at a temperature above the Curie point. It was found at $H_c \sim \nu^{1/4}$, where ν is the number of cycles.

11430 THE FERROMAGNETISM OF THE COMPOUND γ-FeSn. M.Asanuma.
J. Phys. Soc. Japan, Vol. 15, No. 7, 1343 (July, 1960).

The saturation magnetization was found to be 1.8 μ_B per Fe atom and the Curie temperature 676°K. E.P.Wohlfarth

11431 MAGNETIC PROPERTIES OF $Mn_xCr_{1-x}O_2$. K.Siratori and S.Iida.
J. Phys. Soc. Japan, Vol. 15, No. 1, 210-11 (Jan., 1960).

Measurements were made of saturation magnetization and lattice parameters. The magnetization of the ferromagnetic compositions on the chromium-rich side lies about half-way between the theoretical curves expected from a model of antiferromagnetic interaction between Mn^{4+} and Cr^{4+} ions and one of simple dilution. The magnetic moment of a Cr^{4+} ion is found to be 2.00 Bohr magnetons. R.Parker

11432 EFFECT OF CHEMISORBED HYDROGEN ON THE MAGNETIZATION OF NICKEL.
R.E.Dietz and P.W.Selwood.
J. chem. Phys. (USA), Vol. 35, No. 1, 270-81 (July, 1961).

The effect of chemisorbed hydrogen on the saturation magnetization of nickel was investigated on fine particles of nickel. For certain preparations the saturation moment of the nickel was within 1 or 2% of that of massive nickel; this is considered evidence that the surfaces of the nickel in these samples were substantially free from chemisorbed impurities, and that the electronic state of the nickel was identical to that of massive nickel. For these preparations, hydrogen decreases the saturation moment of the nickel by about 0.7 Bohr magneton per average atom of hydrogen adsorbed. This effect appears independent of temperature up to 300°K (the highest temperature investigated) and of surface coverage over nearly the entire range.

11433 KERR HYSTERESIS: A PHENOMENON OF SURFACE MAGNETIZATION. J.Kranz and B.Passon.
Z. Phys. (Germany), Vol. 161, No. 5, 525-38 (1961). In German.

The surface magnetization of a single crystal of silicon–iron was studied using the Kerr effect. Hysteresis curves deviating from the usual forms were obtained. A.J.Manuel

11434 MEASUREMENT OF THE MAGNETIZATION IN THE SURFACE OF SILICON–IRON SINGLE CRYSTALS BY MEANS OF THE AMPLIFIED MAGNETO-OPTICAL FARADAY EFFECT. J.Kranz and B.Passon.
Z. angew. Phys. (Germany), Vol. 13, No. 3, 122-4 (March, 1961). In German.

"Ferromagnetism Working Party" Wiesbaden, 1960 (see Abstr. 7736 of 1961). It is found that the processes of magnetization at the surface are very different from those in the bulk material. An explanation for the anomalous surface behaviour is offered. C.A.Hogarth

11435 ON THE EFFECT OF HEAT TREATMENT IN A MAGNETIC FIELD ON MAGNETIC PROPERTIES OF IRON–ALUMINIUM ALLOYS. M.Sugihara.
J. Phys. Soc. Japan, Vol. 15, No. 8, 1456-60 (Aug., 1960).

When the specimens of Fe–Al alloys were cooled in a magnetic field from high temperatures, the % Al. When the quenched specimen of 10.20% Al was annealed again at various temperatures in a magnetic field and cooled in the field, the lowest effective temperature of heat treatment in a field became about 225° ~ 250° C. This temperature is 100° C lower than the usual lowest effective temperature for the specimen without quenching. Maximum permeability of the specimen which was quenched at first and heat treated at about 250° C in a magnetic field reached the highest value of about 30 000.

11436 FINE STRUCTURE OF WEISS DOMAINS ON {110} FACES OF FeSi SINGLE CRYSTALS IN TERMS OF MAGNETIC FIELD STRENGTH AND DIRECTION.
R.Kohlhaas and G.Ballensiefen.
Z. angew. Phys. (Germany), Vol. 13, No. 3, 131-4 (March, 1961). In German.

"Ferromagnetism Working Party" Wiesbaden, 1960 (see Abstr. 7736 of 1961). Describes experiments with iron crystals containing 3.5% Si, using the method of Bitter figures. The fine structure observed is tentatively explained in terms of the crystal structure of the specimens. C.A.Hogarth

11437 ON THE INFLUENCE OF THE FORMATION OF SUBGRAIN STRUCTURES ON THE MAGNETIC PROPERTIES OF PURE IRON. G.Montalenti and C.Sari.
Nuovo Cimento (Italy), Vol. 19, No. 3, 605-8 (Feb. 1, 1961).

Substructures can reduce μ_{max} by a factor of 8. Once formed they are extremely stable, and cannot be eliminated by prolonged annealing; they seem to be more easily produced in pure iron reduced from the oxide. D.J.Oliver

11438 INDUCED MAGNETIC ANISOTROPY OF EVAPORATED Ni–Fe FILMS.
M.Takahashi, D.Watanabe, T.Kōno and S.Ogawa.
J. Phys. Soc. Japan, Vol. 15, No. 7, 1351-2 (July, 1960).

Ni–Fe alloy films were evaporated on to a quartz plate under a magnetic field of 250 Oe. The thickness was always 600 A and a wide range of compositions was covered. It was found that the induced magnetic anisotropy was larger in thin films and went to a maximum at 50% Ni–Fi, provided the substrate was held at room temperature. If the substrate was held at 300° C and then cooled or annealed at 450° C for 2.5 hr the position of the maximum was displaced to 65% Ni–Fe. A detailed report is to be published. T.C.Toye

11439 THE INFLUENCE OF LOCAL ANISOTROPY FLUCTUATIONS ON THE MAGNETIC PROPERTIES OF THIN NiFe FILMS. S.Middelhoek.
Z. angew Phys. (Germany), Vol. 13, No. 3, 151-4 (March, 1961). In German.

"Ferromagnetism Working Party", Wiesbaden, 1960 (see Abstr. 7736 of 1961). The influence of anisotropy fluctuations on the magnetization reversal process in the direction of difficult magnetization in thin 80% Ni 20% Fe films was studied. The anisotropy fluctuations lead to a splitting of the film into many domains with the appearance of a remanence and irreversible processes. The anisotropy fluctuations produce a coercivity contribution, independent of the mean anisotropy, which decreases with increasing anisotropy constant. A.J.Manuel

IMPROVED NICKEL-BASE ALLOYS FOR MAGNETOSTRICTIVE TRANSDUCERS. See Abstr. 10564

11440 THICKNESS-DEPENDENCE OF STRESS IN VACUUM DEPOSITED SILVER FILMS.

K.Kinosita and H.Kondo.

J. Phys. Soc. Japan, Vol. 15, No. 7, 1339 (July, 1960).

It is shown that previous observation by the author concerning the relation between tensile stress and film thickness can be best fitted by a curve of the form σd = constant, where σ = tensile stress; d = film thickness. A tentative explanation is given which suggests that all the stress is due to a thin film of thickness about 10 A situated adjacent to the free surface or to the substrate surface and that the thickness of the whole film has no effect. It is thought that it is most probably the layer adjacent to the free surface because films deposited on the bell jar often curl up with the free surface concave. For further discussion see following abstract.

T.C.Toye

11441 STRESS IN VERY THIN VACUUM-EVAPORATED FILMS OF SILVER.

K.Kinosita, H.Kondo and I.Sawamura.

J. Phys. Soc. Japan, Vol. 15, No. 5, 942-3 (May, 1960).

Stresses in silver films 30-2500 A thick, evaporated on mica substrates were determined by measurement of deflection of the coated mica. The stress rose rapidly with decrease of thickness below 500 A to values several time that of bulk silver. Above 500 A there was a slight increase with thickness. It is suggested that the stress is concentrated in a surface layer of the film.

V.J.Hammond

11442 THE RECOVERY OF INITIAL MAGNETIC SUSCEPTIBILITY IN PURE NICKEL. M.Asanuma.

J. Phys. Soc. Japan, Vol. 15, No. 8, 1469-4 (Aug., 1960).

The process of recovery in cold-worked pure Ni was investigated by means of the initial magnetic susceptibility and the electrical resistance measurements. In the specimens, which were elongated by about 5%, the recovery of the initial magnetic susceptibility was observed above 450°C, and could not be observed below that temperature. The recovery in the temperature range of the investigation was expressed by logarithmic law, and analysed by Kuhlmann' s formulation (Abstr. 1539 of 1949), its activation energy being 3.0 eV. This value is in good agreement with the activation energy of vacancy migration. Therefore, it must be assumed that the disappearance of vacancies does not affect the initial magnetic susceptibility.

11443 MAGNETOSTRICTION OF A SINGLE CRYSTAL OF NICKELIFEROUS IRON OF LOW NICKEL CONTENT.

S.S.Fonton.

Kristallografiya (USSR), Vol. 5, No. 1, 153-4 (Jan.-Feb. 1960).

In Russian.

The variation of the linear magnetostriction constants for the [100], [110] and [111] directions up to saturation magnetisation are reported from measurements on picture frame specimens cut from the same single crystal of an alloy containing 94% Fe, 5.48% Ni. [English translation in: Soviet Physics – Crystallography (USA), Vol. 5, No. 1, 145-6 (July-Aug., 1960)].

A.J.Manuel

11444 VOLUMF AND SURFACE MAGNETO-ELASTIC WAVES IN METALS. S.V.Peletmȳn'skȳi.

Ukrayin. fiz. Zh. (USSR), Vol. 3, No. 5, 611-16 (1958). In Ukrainian, with summary (1 p.) in Russian.

The effect of an external magnetic field on the elastic properties of the metal is due to the conductivity of the medium. Calculations are given for the changes in the velocity of sound and the additional absorption of sound due to the presence of an external field and conductivity. The propagation of surface (Rayleigh) magneto-elastic waves in metals is considered.

11445 THEORY OF MAGNETOSTATIC MODES IN LONG, AXIALLY MAGNETIZED CYLINDERS.

R.I.Joseph and E.Schlömann.

J. appl. Phys. (USA), Vol. 32, No. 6, 1001-5 (June, 1961).

The characteristic equation determining the eigenfrequencies of the magnetostatic modes is derived from the equations of motion and the boundary conditions. The solutions may be classified as pertaining to surface and to volume modes. Surface-mode solutions exist only for sufficiently small wave numbers, and their eigenfrequencies are larger than those of volume modes. The eigenfrequencies generally decrease with increasing wave number. Approximate analytic expressions for the dependence of the eigenfrequencies on wave number are obtained for the regions in which the wavelength is either much smaller or much larger than the cylinder radius. The approximate expressions are compared with numerical results obtained by means of an electronic computer.

11446 INSTABILITY OF SPIN WAVES AND MAGNETOSTATIC MODES IN A MICROWAVE MAGNETIC FIELD APPLIED PARALLEL TO THE D.C. FIELD. E.Schlömann and R.I.Joseph.

J. appl. Phys. (USA), Vol. 32, No. 6, 1006-14 (June, 1961).

Two methods of calculating the instability threshold are described. The first is a plane-wave analysis which is strictly applicable only in an infinite medium. The second is a more rigorous theory in which the boundary conditions at the surface of the sample are taken into account. The refined theory admits instabilities at frequencies different from half the pump frequency which are forbidden according to the less rigorous plane-wave analysis. The general theory is applied to the magnetostatic modes of a long, circular cylinder, which is magnetized along its axis. It is concluded that: (a) Instability at half the pump frequency can occur only for those cases in which the magnetostatic potential is invariant under rotation around the cylinder axis (m = 0). The instability threshold for these modes is identical to that deduced on the basis of the plane-wave analysis, except that the frequencies now have to satisfy the characteristic equation derived from the boundary conditions. (b) Instabilities at frequencies different from half the pump frequency can occur, but generally have a high threshold. (c) Pairs of surface modes (with frequencies higher than the highest plane-wave frequency) are not subject to instability. (d) Instabilities involving a surface mode and a volume mode are not strictly forbidden. It is very likely, however, that such instabilities will be masked by the instability of spin waves of shorter wavelength.

11447 PERMALLOY ALLOYS WITH RECTANGULAR HYSTERESIS LOOPS. F.Pfeifer.

Z. angew. Phys. (Germany), Vol. 13, No. 4, 177-80 (April, 1961). In German.

"Ferromagnetism Working Party", Wiesbaden, 1960 (see Abstr. 7736 of 1961). The effects of magnetic annealing below the Curie points and normal annealing above the Curie points were studied for 7 alloys containing approximately 79% Ni, 0-7% Mo, the remainder Fe.

A.J.Manu

11448 UNPAIRED SPIN DENSITY IN ORDERED Fe_3Al.

S.J.Pickart and R.Nathans.

Phys. Rev. (USA), Vol. 123, No. 4, 1163-71 (Aug. 15, 1961).

A precise determination of the magnetic form factor of the ordered alloy Fe_3Al was made by diffraction of polarized neutrons from a single crystal. Some 43 reflections in the angular range $\sin\theta/\lambda \leq 0.9$ A^{-1} was examined and show characteristic departures from a smooth single-valued function, indicating that the unpaired electron density in the unit cell is not spherically symmetric. The data are analysed in two ways: by comparison with form factors calculated from free-atom Hartree–Fock wave functions including crystal-field splitting effects, and by two-dimensional Fourier projections of the unpaired spin density. The analysis indicates that, while the two types of iron atom in the lattice have similar radial spin densities, their orbital symmetry is different. The results are discussed with reference to various theories of the electronic structure in transition metals.

11449 TEMPERATURE DEPENDENCE OF THE MAGNETIZATION OF HEXAGONAL FERRITES IN WEAK FIELDS.

E.S.Borovik and Yu.A.Mamalui.

Fiz. Metallov i Metallovedenie (USSR), Vol. 9, No. 6, 828-31 (1960). In Russian.

The temperature dependences of the magnetization of barium, lead and strontium ferrites in weak fields were investigated experimentally. In these ferrites the Hopkinson effect (the increase of the initial susceptibility near the Curie point) was found to be absent. In cobalt ferrite, the Hopkinson effect was present. Also the susceptibility reached a maximum in the region where the anisotropy constant changed sign.

N.Dav

11450 SQUARE-LOOP FERRITES WITH TEMPERATURE-INDEPENDENT PROPERTIES AND IMPROVED DISTURB RATIO. R.S.Weisz.

J. appl. Phys. (USA), Vol. 32, No. 6, 1152-3 (June, 1961).

Magnetic annealing of manganese–ferrous ferrites and nickel ferrous ferrites produced memory cores with lower temperature coefficients and higher disturb ratios than conventional square-loop ferrites. 50 mil diameter toroids of composition $0.5\ NiFe_2O_4 \cdot 0.5\ Fe_3O_4$ switch in approximately 1 μsec with a

stant 1 A driving current, and have disturb ratios greater than over the range -55° to + 100°C. Physical reasons for the proved properties are discussed.

11451 ORIENTATION SUPERSTRUCTURE IN Fe-Ni FERRITE SINGLE CRYSTALS. R.Wagner.
Angew. Phys. (Germany), Vol. 13, No. 4, 187-9 (April, 1961).
German.

"Ferromagnetism Working Party", Wiesbaden, 1960 (see str. 7736 of 1961). Uniaxial anisotropy was induced in a single stal sphere of $Fe_{0.25}Ni_{0.75}Fe_2O_4$ by heating for ½ hr at 330°C he presence of a magnetic field in the direction of the cube es of the spinel lattice. Measurements of the time variation of anisotropy at different temperatures in a field inclined at 45° the original field were made and an activation energy between and 1.9 eV was deduced for the diffusion process responsible the induced anisotropy. A.J.Manuel

11452 MAGNETIC MOMENT OF LANTHANUM MAGNETOPLUMBITE FERRITE. A.Aharoni and M.Schieber.
ys. Rev. (USA), Vol. 123, No. 3, 807-9 (Aug. 1, 1961).
$La^{3+}Fe^{2+}Fe_{11}^{3+}O_{19}$ was prepared by sintering the oxides, and its agnetic moment was measured from liquid-air temperature to the rie point. At the lowest temperature a value of 17.5 Bohr agnetons per formula weight was obtained, as compared with Bohr magnetons of $BaFe_{12}^{3+}O_{19}$. The difference is qualitatively derstood if the Fe^{3+} ion is a nearest neighbour to the La^{3+} in the ystal, i.e. in the [12K] site, thus decreasing the total magnetic oment. The Curie temperature is 695°K, compared to 725°K of $Fe_{12}^{3+}O_{19}$. The lower Curie point can again be qualitatively plained by less exchange interaction with the divalent iron of $Fe^{2+}Fe_{11}^{3+}O_{19}$, or possibly by the change in unit cell dimension ich modifies the short-range exchange interaction between the on ions.

11453 SOME PROPERTIES OF MIXED RARE-EARTH GARNETS WITH ALUMINIUM AND CHROMIUM BSTITUENTS. G.Villers and J.Loriers.
Phys. Radium (France), Vol. 21, No. 10, 753-4 (Oct., 1960).
French.

Experimental results are presented in graphical form for the ixed garnets defined by the following relations:

$$(5 - x)Fe_2O_3.xMe_2O_3.2Gd_2O_3.Y_2O_3, \text{ and}$$

$$(5 - x)Fe_2O_3.xMe_2O_3.2Gd_2O_3.Er_2O_3,$$

here the value of x = 0-0.5 for Me = Cr and x = 0-1 for Me = Al. or both systems the addition of Al and Cr lowers the Curie emperature in an almost identical manner, while the addition of Al ncreases and Cr decreases the compensation temperature.
A.P.C.Thiele

11454 HYPERFINE INTERACTIONS IN THE GROUND STATE AND FIRST EXCITED STATE OF Dy^{161} IN DYSPROSIUM RON GARNET. R.Bauminger, S.G.Cohen, A.Marinov and S.Ofer.
Phys. Rev. Letters (USA), Vol. 6, No. 9, 467-70 (May 1, 1961).

The hyperfine Zeeman splittings in the recoil-free absorption spectrum of the 26 keV γ-rays from Dy^{161m} were observed in Dy^{161} situated in dysprosium iron garnet. Values for the effective magnetic field at the nucleus H_{eff} and the magnetic and quadrupole moments of the ground state and first excited state of Dy^{161} are derived. H_{eff} appears to be proportional to the spontaneous magnetization. The magnetic moment of the excited state is +0.42 ± 0.08 n.m. There is a remarkably large quadrupole interaction ($eqQ_1/4$ = +120 Mc/s) at 85°K which is much smaller (<20 Mc/s) at 300°K. This remarkable temperature sensitivity is interpreted as due largely to the average electric field gradient produced by the partially aligned orbitals of the 4f electron shell and correlated with the spontaneous magnetization within each domain. J.M.Baker

11455 MAGNETIC ANOMALY IN $FeTiO_3$–αFe_2O_3 SYSTEM BY MÖSSBAUER EFFECT. S.L.Ruby and G.Shirane.
Phys. Rev. (USA), Vol. 123, No. 4, 1239-40 (Aug. 15, 1961).

The solid solutions $(1 - x)FeTiO_3$–xFe_2O_3 exhibit strong ferrimagnetic moments for the compositions $x < 0.6$, where the Fe and Ti ions are ordered in the alternate (111) layers. The anomaly revealed by the Mössbauer measurements is that the ferrimagnetic phase consists of ferrimagnetic clusters surrounded by paramagnetic media. The size of these clusters decreases with increasing temperature or increasing local concentration of Ti. The isomer shift of $FeTiO_3$ is 1.2 mm/sec at room temperature as expected for Fe^{2+}, although the quadrupole splitting of 0.62 mm/sec is smaller than that observed in other ferrous environments.

11456 THE THEORY OF RELAXATION PROCESSES IN AN ANTIFERROMAGNETIC.
M.I.Kaganov, V.M.Tsukernik and I.E.Chupis.
Fiz. Metallov i Metallovedenie (USSR), Vol. 10, No. 5, 797-8 (Nov., 1960). In Russian.

The mean probability of the occurrence of the processes determining the interaction of spin waves with each other in an antiferromagnetic is calculated, starting with the Hamiltonian corresponding to such an interaction. The contents of one bracket represent the combination of two spin waves to form one, while those of another represent the scattering of two spin waves. The mean probability of the occurrence of the two kinds of events is calculated separately. N.Davy

11457 THE SUSCEPTIBILITY OF AZURITE.
M.Garber and R.Wagner.
Physica (Netherlands), Vol. 26, No. 10, 777 (Oct., 1960).

Measurements on a single crystal indicate that the antiferromagnetic transition occurs at about 2.0°K. A.J.Manuel

11458 MAGNETIC ANISOTROPY OF CHALCOPYRITE.
T.Teranishi.
J. Phys. Soc. Japan, Vol. 15, No. 6, 1123 (June, 1960).

The torque curve and the parallel and perpendicular susceptibilities of a single crystal of $CuFeS_2$ as well as the powder susceptibility were measured. The material is antiferromagnetic with a Néel temperature 550°C. E.P.Wohlfarth

11459 ON THE MAGNETIC PROPERTIES OF THE COMPOUND Mn_2As. M.Yuzuri and M.Yamada.
J. Phys. Soc. Japan, Vol. 15, No. 10, 1845-50 (Oct., 1960).

The thermomagnetic properties of the compound were investigated together with the phase diagram of Mn–As system. From the results of measurements of the temperature dependence of magnetic susceptibility and specific heat of the compound Mn_2As, it was found that this alloy is antiferromagnetic with the Néel point at 573°K. The reciprocal of its susceptibility obeys the Curie–Weiss law in the high temperature range, but a considerable deviation therefrom can be see just above the Néel point as in the case of ferrimagnetism. Based on the Curie constant obtained by the present experiment, the effective magneton number was calculated to be 5.2 per manganese ion. The total heat absorption due to the vanishing of antiferromagnetic order of spins in the present alloy was estimated to be 230 cal per mol. A discussion based on the molecular field theory is given on the nature of the above-mentioned magnetic properties.

11460 ABRUPT MAGNETIC TRANSITION IN $MnSn_2$.
J.S.Kouvel and C.C.Hartelius.
Phys. Rev. (USA), Vol. 123, No. 1, 124-5 (July 1, 1961).

The magnetic susceptibility and the electrical resistivity of the intermetallic compound $MnSn_2$ are found to decrease precipitously as the temperature is lowered through 73°K. Both these abrupt changes exhibit a small temperature hysteresis and are highly suggestive of a first-order transition. From 73°K down to 4.2°K, the susceptibility is essentially constant; above 73°K, the susceptibility rises slowly to a maximum (at 86°K) and then decreases in a manner consistent with the Curie–Weiss relation. It is tentatively concluded that the abrupt transition at 73°K involves only a partial disordering of an antiferromagnetic state.

Magnetic Resonances

11461 GYROMAGNETIC RATIO OF NICKEL FERRITE.
G.G.Scott.
Phys. Rev. (USA), Vol. 123, No. 2, 434 (July 15, 1961).

The gyromagnetic ratio of the ferrite $NiOFe_2O_3$ was determined by measurements of the Einstein–de Haas effect. The g' value of 1.849 ± 0.002 indicates that the magnetization is largely due to the N^{++} ions as in the Néel model. Comparison with values of g determined by ferromagnetic resonance investigations furnished evidence as to the validity of the Kittel–Van Vleck relation for ferrites.

11462 GYROMAGNETIC RATIO OF PYRRHOTITE.
G.G.Scott and A.J.P.Meyer.
Phys. Rev. (USA), Vol. 123, No. 4, 1269 (Aug. 15, 1961).

The gyromagnetic ratio of pyrrhotite was determined by measurements of the Einstein–de Haas effect. The value obtained for g' is 1.9 ± 15%.

11463 A FEW CONSEQUENCES OF THE THEORY OF PHASES OF ELEMENTARY DOMAINS ON FERROMAGNETIC RESONANCE. A.Coumes.
Arch. Sci. (Switzerland), Vol. 13, No. Fasc. Spec., 325-30 (1960). In French.

9th Colloque Ampère Paper (see Abstr. 4734 of 1961). Applies Néel's theory to the calculation of the form of the magnetic resonance line for a single crystal sample of FeSi. Good agreement with experiment is obtained and the formulae derived enable the anisotropy field to be obtained from the experiments.

D.J.Oliver

11464 THE TEMPERATURE AND PRESSURE DEPENDENCE OF THE NUCLEAR RESONANCE OF Co^{59} IN FACE-CENTERED-CUBIC COBALT METAL.
Y.Kōi, A.Tsujimura and Y.Yukimoto.
J. Phys. Soc. Japan, Vol. 15, No. 7, 1342 (July, 1960).

The hyperfine interaction of f.c.c. cobalt metal is studied as a function of pressure and temperature by means of a n.q.r. spectrometer. Diagrams are given of the resonance frequency in the temperature range from liquid air to 800° K and at pressures up to 10 000 kg/cm^2. F.Bruin

11465 MAGNETIC ANISOTROPY OF IRON—COBALT FERRITE MEASURED BY FERROMAGNETIC RESONANCE. Y.Sugiura.
J. Phys. Soc. Japan, Vol. 15, No. 8, 1461-8 (Aug., 1960).

The cubic magnetic anisotropy K_1/M and the uniaxial magnetic anisotropy K_T/M induced by heat treatment in magnetic field were measured in the temperature range between 70° and 250° C. The secondary peak observed in the ferromagnetic resonance are explained by the domains having different orientation of uniaxial magnetic axis. From the experimental results the g-factor is determined to be 2.86. The temperature dependence of the g-factor was not observed within limits of errors.

11466 SIZE EFFECT FOR MAGNETOSTATIC MODES OF THE TYPE (n, n, 0) IN A FERRITE CYLINDER. R.Plumier.
Physica (Netherlands), Vol. 27, No. 4, 403-5 (April, 1961).

An expression is obtained for the frequency shift in ferromagnetic resonance in a ferrite cylinder. The method is similar to that used previously (Abstr. 2492 of 1961). S.A.Ahern

11467 PRIMITIVE THEORY OF FERRIMAGNETIC RESONANCE FREQUENCIES IN RARE-EARTH IRON GARNETS.
J.H.Van Vleck.
Phys. Rev. (USA), Vol. 123, No. 1, 58-62 (July 1. 1961).

The effective g-factor for ferrimagnetic resonance frequencies in rare-earth iron garnets is calculated by direct inspection of eigenvalues rather than study of the equations of motion. The rare-earth ions are treated as captive in the exchange field from the iron, but subject to decomposition of their energy levels by crystalline fields and/or spin—orbit interaction. With a crystalline field, the problem is tractable in a simple way only if these decompositions are large or small compared to those which could be produced by the exchange field acting alone. Anisotropy, actually very important at low temperatures, is neglected except insofar as it can be represented by an anisotropy field. The concept of "fictitious spin" is useful, and the spectroscopic splitting factors turn out to be more relevant than the true gyromagnetic ratios. For europium garnet, this theory becomes essentially that of Wolf. It is shown that Kittel's formula $g_{eff} = 2(M_{Fe} + M_{RE})/M_{Fe}$ has approximate validity if most of the magnetic moment of the rare earth arises from nondiagonal matrix elements joining ionic energy levels with separations large compared with the Zeeman energy in the exchange field. The fact that in certain cases the experimental results are represented fairly well by Kittel's formula is hence not necessarily to be construed as evidence that the rare-earth ion is highly damped by spin—lattice interaction as in his original model.

11468 PRESSURE DEPENDENCE OF THE MICROWAVE RESONANCE PROPERTIES OF SOME SPINEL AND GARNET FERRITES. I.P.Kaminow and R.V.Jones.
Phys. Rev. (USA), Vol. 123, No. 4, 1122-9 (Aug. 15, 1961).

The anisotropy field, g value, and linewidth of several spinel and garnet ferrites were measured at X band and room temperature as functions of hydrostatic pressure to 10^4 kg/cm^2. The crystals studied include yttrium, ytterbium, and erbium iron garnet; magnesium ferrite (with different distrbutions of Mg^{2+} ions on A and B sites); and $Ni_{1-z}Co_zFe_2O_4$ with z = 0, 0.05 and 0.10. The pressure dependence of magnetization was measured using magnetostatic mode methods in the narrow linewidth materials, yttrium iron garnet and magnesium ferrite. The complexity of the crystal structure and magnetic interactions makes any quantitative interpretation very difficult. However, the observations can be understood qualitatively in terms of the volume dependence of the crystalline fields and the exchange interactions. In the case of erbium iron garnet, the volume dependence of the ferric—rare-earth exchange constant is calculated; and, in the case of nickel cobalt ferrite, a simple explanation is offered for the observed volume dependence of the Co^{2+} anisotropy. The contribution of thermal lattice vibrations to the linewidth in yttrium iron garnet discussed, and the possibility of an anisotropic spin—orbit interaction is considered.

11469 ANTIFERROMAGNETIC RESONANCE IN FeF_2 AT FAR-INFRARED FREQUENCIES.
R.C.Ohlmann and M.Tinkham.
Phys. Rev. (USA), Vol. 123, No. 2, 425-34 (July 15, 1961).

Antiferromagnetic resonance in single crystals of FeF_2 was obtained between 1.5° and 66° K (T_N = 78.4° K) in the far-infrared region. The resonance frequency at T ≅ 0 was found to be $\bar{\nu}(0) = 52.7 \pm 0.2$ cm^{-1}. Using the antiferromagnetic resonance relation derived by Kittel, Nagamiya, Keffer, and others, and using the experimental value for the static susceptibility, the uniaxial anisotropy constant at absolute zero, K(0), was inferred to be 1.1×10^8 ergs/cm^3 (40 cm^{-1}/atom). Measurements of the splitting of the line caused by an external magnetic field gave $g_{||} = 2.25 \pm 0$. The anisotropy energy in FeF_2, being primarily due to the crystal field—spin—orbit interaction, may be described by a term $\Sigma_i DS_{z_i}^2$ in the Hamiltonian. By including this interaction in the molecular field treatment, the authors found D = −9 ± 2 cm^{-1}, and calculated the temperature dependences of the sublattice magnetization, the anisotropy constant, the resonance frequency, and the line-width. The last two were compared with the experimental results and found to be in reasonable agreement. The line-widths were found to follow a T^4 law above 15° K. The search over a frequency region of 13-70 cm^{-1} for the absorption lines expected in the paramagnetic region was unsuccessful, possibly indicating a relaxation time of less than 10^{-12} sec.

11470 CALCULATIONS OF LINE SHAPE FOR E.S.R. ABSORPTION IN POLYCRYSTALLINE SUBSTANCES.
J.W.Searl, R.C.Smith and S.J.Wyard.
Arch. Sci. (Switzerland), Vol. 13, No. Fasc. Spec., 236-8 (1960).

9th Colloque Ampère Paper (see Abstr. 4734 of 1961). The calculation was performed for crystals having one type of magnetic ion with a uniaxial g-tensor for both Gaussian and Lorentzian lines. The theoretically calculated shapes are compared with experimental curves for ultraviolet-irradiated deuterium peroxide.

J.M.Ba

11471 THE QUADRUPOLE MOMENT OF THE COMPONENT OF THE FINE STRUCTURE OF THE NUCLEAR AND ELECTRONIC PARAMAGNETIC RESONANCE LINES IN MAGNETICALLY DILUTE CRYSTALS. U.Kh.Kopvillem.
Fiz. Metallov i Metallovedenie (USSR), Vol. 9, No. 5, 657-61 (196
In Russian.

Investigates theoretically the dependence of the quadrupole moment on the symmetry and crystal electric field. The resonance line-width is calculated as a function of temperature, spin—spin interaction, and concentration of magnetic ions. M.G.Pries

11472 CYCLOTRON AND PARAMAGNETIC RESONANCE IN DEFORMED CRYSTALS. G.E.Pikus and G.L.Bir.
Fiz. tverdogo Tela (USSR), Vol. 3, No. 3, 1001-4 (March, 1961).
In Russian.

For abstract, see Abstr. 10178 of 1961. [English translation in: Soviet Physics—Solid State (USA), Vol. 3, No. 3, 730 (Sept., 1

11473 ELECTRON SPIN RESONANCE OF CRYSTALLINE FREE RADICALS. J.I.Kaplan.
J. chem. Phys. (USA), Vol. 34, No. 6, 2205-6 (June, 1961).

It is pointed out that Van Vleck's expression (Abstr. 949 of 1949) for the spin resonance linewidth in solids must be modified if the local "spin sites" are not ions but molecules. The linewidth depends upon the spatial distribution of the molecular wave function. In a simple example it is shown that taking into account the non-localized character of the spin changes the mean square linewidth by a factor of 20. J.M.Ba

11474 TRITIUM AS A SOURCE OF RADIATION IN ELECTRON SPIN RESONANCE STUDIES.
J.Kroh, B.C.Green and J.W.T.Spinks.
Nature (GB), Vol. 189, 655-6 (Feb. 25, 1961).

The use of internally emitted tritium β-particles for irradia

aterials for electron spin resonance is briefly described. This nique has the considerable advantage that the presence of inter- ng spectra from the glass or quartz container of the sample are ided, no such effect being observed for radiation doses of up to 10^{20} eV/ml. S.A.Ahern

11475 PHONON MASERS AND THE PHONON BOTTLENECK. C.Kittel.
s. Rev. Letters (USA), Vol. 6, No. 9, 449 (May 1, 1961).
Examines basic conditions for phonon maser action, with amagnetic ions radiating the lattice phonons. Van Vleck (str. 1669 of 1941) has pointed out that in some circumstances the ice phonons cannot always carry off all the power delivered to n by a paramagnetic system, with one-phonon direct coupling. ier representative conditions it appears feasible to obtain a non "bottleneck" leading to maser action. P.M.Parker

11476 PARAMAGNETIC RESONANCE OF Cr^{3+} IN A SINGLE CRYSTAL OF $AlCl_3.6H_2O$. G.Emch and R.Lacroix.
lv. phys. Acta (Switzerland), Vol. 33, No. 9, 1021-31 (1960).
The complex $Cr(H_2O)_6^{3+}$ diluted in a single crystal of aluminium loride was studied by paramagnetic resonance at about 3 cm velength. The system can be described by the usual spin miltonian for axial symmetry with paramaters: $= 1.9769 \pm 0.0004$, $g_{\parallel} - g_{\perp} = + (5 \pm 2) \times 10^{-4}$, $= + (6.52 \pm 0.01) \times 10^{-2}$ cm^{-1}. From these results and those optical absorption measurements (Abstr. 4132 of 1938) the valency factor of the Cr—H_2O bond is estimated to be 0.39. A eoretical explanation is given of the rather small value of D and the optical absorption; the crystalline electric field at the Cr^{3+} te due to the Cl^- ions and the H_2O dipoles, and the separate effect induced dipole moments and the distortion of the water dipoles ie to bonding with the Cl^- ions, is evaluated. J.M.Baker

11477 OCCURRENCE OF Cr^{3+} IN KYANITE. G.J.Troup.
istral. J. Sci., Vol. 23, No. 8, 270-1 (Feb., 1961).
Attempts were made to measure the paramagnetic resonance ectrum of Cr^{3+} in kyanite (Al_2SiO_5, triclinic) because of its ssible application as a solid-state maser material, since optical easurements (Abstr. 4965 of 1934) indicate zero-field splitting 33 cm^{-1}. Measurements were made in the region of 10 kMc/s, it no samples were obtained free from Fe^{3+} impurity. This renders valuation of the spectra extremely difficult, but tentatively the bserved paramagnetic resonance lines are assigned to Cr^{3+} and e^{3+}. A need is expressed for samples containing 0.5 - 0.05% Cr^{3+} ith at most $\frac{1}{10}$th of this proportion of Fe^{3+}. S.A.Ahern

11478 E.S.R. DETECTION OF THE HYDROLYSIS OF SOLID CaF_2. J.Sierro.
. chem. Phys. (USA), Vol. 34, No. 6, 2183-4 (June, 1961).
The hydrolysis was studied at high temperatures (900-1200°C) y ESR of Gd^{+++} substituted for Ca^{++} in a synthetic crystal doped with 0.01% Gd, several natural crystals, and crystalline powders loped by thermal diffusion. The observed spectra depended upon he temperature and duration of the thermal treatment. At the beginning of the hydrolysis, spectra are observed due to OH^- replacing F^- neighbours of the Gd^{+++}. Later in the reaction the OH^- becomes O^{2-}. When more O^{2-} ions have diffused into the crystal F^- vacancies are formed, which give a characteristic sharp F centre resonance line at $g = 1.991 \pm 0.001$. J.M.Baker

11479 E.S.R. LINE SHAPES IN GLASSES OF COPPER COMPLEXES. R.Neiman and D.Kivelson.
J. chem. Phys. (USA), Vol. 35, No. 1, 156-61 (July, 1961).
The study by Sands (Abstr. 8914 of 1955) of ESR line shapes of polycrystalline copper complexes is extended and various "anomalies" are discovered in the line shapes. The spectrum of copper phthalocyanine dissolved in concentrated H_2SO_4 was studied at 77°K. The $M = -\frac{3}{2}$ hyperfine line has a behaviour very different from that discussed by Sands. Isotropic extra hyperfine structure, arising from the presence of the ligand nitrogens, is easily discernible even in the glass.

11480 THE ELECTRON PARAMAGNETIC RESONANCE OF Mn^{2+} IONS SURROUNDED BY AN OCTAHEDRON OF FLUORINE IONS. S.Ogawa.
J. Phys. Soc. Japan, Vol. 15, No. 8, 1475-81 (Aug., 1960).
The measurements of the e.p.r. of Mn^{2+} ions as dilute, substitutional impurities in the single crystals of $KMgF_3$, $KCdF_3$, $KCaF_3$, K_2MgF_4 and $NaMgF_3$ were made. An X-ray examination revealed that divalent metal ions in these crystals were surrounded by an octahedron of six fluorine ions. The F^{19} "super-h.f.s." superimposed on the usual h.f.s. of Mn^{55} was observed. The dependence of the F^{19} h.f. interaction constant (A_S) upon the Mn^{2+}-F^- distance was noticed and discussed. The A_S in $KMnF_3$ was estimated to be somewhat smaller than 16.7×10^{-4} cm^{-1}.

11481 EXCHANGE INTERACTION AND CUBIC CRYSTAL FIELD SPLITTING PARAMETER OF Fe^{3+} IN SPINEL STRUCTURE. Y.Sugiura.
J. Phys. Soc. Japan, Vol. 15, No. 7, 1217-22 (July, 1960).
The line widths of paramagnetic resonance absorption of Fe^{3+} ions in $MgAl_2O_4$ and $ZnAl_2O_4$ polycrystals and of Mn^{2+} ions in $ZnAl_2O_4$, having the same spinel crystal structure as ferrite, were measured as a function of concentration. The cubic crystal field splitting parameters a of Fe^{3+} ion at A- and B-sites were determined from the line widths extrapolated to zero concentration: $a_A = 1.0 \times 10^{-2}$ cm^{-1} and $a_B = 3.1 \times 10^{-2}$ cm^{-1}. $a_B/a_A = 3.1$. On the other hand, the magnitudes of exchange integral between Fe^{3+} ions in A- and B-sites or in B- and B-sites were estimated from the decrease of line width due to exchange narrowing as the concentration increases, namely, $J_{AB}/g\beta = 1.32 \times 10^6$ Oe and $J_{BB}/g\beta = 1.90 \times 10^3$ Oe. The Curie temperatures obtained from the exchange integral are in agreement with the Curie temperature of Mg-ferrite and Zn-ferrite measured experimentally.

ELECTRON SPIN RESONANCE [E.S.R.] INVESTIGATIONS ON M CENTRES IN KCl. See Abstr. 11241

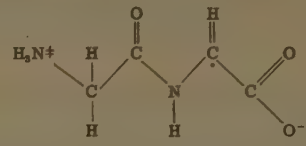
11482 ELECTRON SPIN RESONANCE IN NEUTRON-IRRADIATED QUARTZ. R.H.Silsbee.
J. appl. Phys. (USA), Vol. 32, No. 8, 1459-62 (Aug., 1961).
The electron spin resonance of one of the defects produced by fast neutron irradiation of crystalline quartz is analysed. The g tensor and hyperfine tensors deduced from these results imply that the defect electron is in a nonbonding tetrahedral hybrid orbital on a silicon. It is suggested that the instability of the lattice at high doses results in part from the presence of these defects.

11483 EXCHANGE-ORDERING AND OBSERVATION OF FORBIDDEN SPIN RESONANCE TRANSITIONS IN CRYSTALLINE ORGANIC RADICALS.
R.S.Rhodes, J.H.Burgers and A.S.Edelstein.
Phys. Rev. Letters (USA), Vol. 6, No. 9, 462-3 (May 1, 1961).
The e.s.r. spectra of polycrystalline samples of the organic free radicals picryl-n-amino carbazyl, 1-3-bisdiphenylene-2-phenyl allyl and Wurster's blue perchlorate show a resonance at $g = 4$ at low temperatures and low frequencies. This may arise from a forbidden transition made possible by the dipolar interaction between spins. It is assumed that the dipolar coupling is averaged by electron exchange; the line occurs only at low temperatures where the exchange correlation time is long. Evidence that exchange plays an important role in these radicals is obtained from exchange narrowing of the e.s.r. lines, resonant and static magnetic susceptibility data, low-temperature specific heats, electron and proton relaxation times, and Knight shifts. J.M.Baker

11484 THE LOW-TEMPERATURE VARIATION OF HYPERFINE STRUCTURE IN THE PARAMAGNETIC RESONANCE OF GAMMA-IRRADIATED GLYCINE. R.Servant.
Arch. Sci. (Switzerland), Vol. 13, No. Fasc. Spec., 301-2 (1960).
In French.
9th Colloque Ampère Paper (Abstr. 4734 of 1961). The spectrum found at normal temperatures has the quintet structure observed by Gordy, Ard and Shields (Abstr. 1388 of 1956). When the sample is cooled to -190°C the hyperfine structure changes reversibly to a quartet. The results resemble those simultaneously found by Ghosh and Whiffen (Abstr. 20665 of 1960). An explanation in terms of restriction of intra-molecular movement at low temperatures is favoured. J.Sheridan

11485 ELECTRON SPIN RESONANCE OF γ-IRRADIATED GLYCYLGLYCINE. M.Katayama and W.Gordy.
J. chem. Phys. (USA), Vol. 35, No. 1, 117-22 (July, 1961).
The electron paramagnetic resonance spectra of a gamma-irradiated single crystal of α-glycylglycine were measured at 9, 24, and 29 Mc/s for various orientations of the crystal in the external magnetic field. From analysis of the spectroscopic splitting factors and the hyperfine interaction constants, the free radical

produced by gamma irradiation is found to be:



The electron spin density on the –CH carbon atom is evaluated as approximately 0.75.

11486 E.S.R. SPECTRA OF SOLID PHTHALOCYANINES.
R.Neiman and D.Kivelson.
J. chem. Phys. (USA), Vol. 35, No. 1, 162-4 (July, 1961).

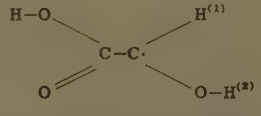
Phthalocyanine complexes of paramagnetic metal ions show ESR spectra characteristic of the metals; phthalocyanine complexes of diamagnetic metal ions show strong single ESR lines characteristic of free radicals. The source of this latter resonance is not understood. Intimate molecular mixtures of "paramagnetic" copper and "dimagnetic" zinc phthalocyanines exhibit exchange between the copper unpaired electron and the "free radical" electron in the zinc phthalocyanine. Nickel and zinc phthalocyanine also exhibit a single sharp resonance in dilute solutions of concentrated sulphuric acid.

11487 PARAMAGNETIC RESONANCE OF X-IRRADIATED SINGLE CRYSTALS OF ROCHELLE SALT.
G.C.Moulton and W.G.Moulton.
J. chem. Phys. (USA), Vol. 35, No. 1, 208-12 (July, 1961).

The electron-spin resonances of single crystals of Rochelle salt and deuterated Rochelle salt irradiated with 40 kV X-rays were studied as a function of orientation of the crystal in the magnetic field. The spectra are time dependent, and by studies of the decay of the spectra it was found that three kinds of centres are present. In Rochelle salt one of these gives rise to an intense doublet which decays rapidly, another to a doublet which grows and then decays, and the third is an eight-line spectrum which grows and is stable. It is shown that the waters of hydration play an important role in the kinetics of the growth and decay of the centres. The stable spectrum was analyzed, and it is concluded that two of the lines arise from breaking one of the C–H bonds. This doublet is slightly anisotropic, and arises from hyperconjugation to the proton on the adjacent carbon, and dipolar coupling between it and the large spin density on the carbon. A second pair of lines arises from breaking the other C–H bond, and since the hydrogens are not equivalent, this pair has a different splitting. The other two pairs are shown to be couplings to either OH or water of hydration hydrogens.

11488 ELECTRON SPIN RESONANCE OF AN IRRADIATED SINGLE CRYSTAL OF UREA OXALATE.
D.V.G.L.Narasimha Rao and W.Gordy.
J. chem. Phys. (USA), Vol. 35, No. 1, 362-8 (July, 1961).

Free radicals produced in a single crystal of urea oxalate by gamma-irradiation were investigated. Only one species of free radical was observed at room temperature. Analysis of the resonance leads to the conclusion that the free radical has the form RCHOH and is probably



with the electron spin density concentrated mostly on the CH carbon. The radical was found to be very stable: its ESR pattern was observed, essentially undiminished, for more than a year after the irradiation. The g factor was found to be only slightly anisotropic, with principal values: $g_u = 2.0024$, $g_v = 2.0048$, and $g_w = 2.0047$. Couplings with two H nuclei are believed to be those indicated by $H^{(1)}$ and $H^{(2)}$, with principal elements of coupling, in gauss, of 15.7, 26.5, and 8.1 for $H^{(1)}$, and of 6.2, –0.3, and 8.3 for $H^{(2)}$. With irradiation and observation at 77°K, a different free radical was observed, one with hyperfine structure from only one H, similar to $H^{(2)}$.

11489 SPIN–LATTICE RELAXATION OF DONOR ELECTRONS IN SILICON. J.Kondo.
Progr. theor. Phys. (Japan), Vol. 24, No. 1, 161-70 (July, 1960).

The relaxation rate is calculated using the adiabatic approximation, in which the electronic wave-function is determined instantaneously according to the Hamiltonian which is perturbed by the lattice deformation. The rate thus obtained is found to be equal to that obtained by taking a simple product of the electronic and the lattice wave-functions as a starting wave-function and by taking the electron–lattice interaction as a perturbation. The modulation of the spin–orbit coupling due to the lattice vibration is considered as well as the deformation of the donor wave-function due to the external magnetic field. When the one-phonon process is considered, the relaxation rate is found to be proportion to H^4T, as is observed. The absolute magnitude of the rate also agrees with that observed in order of magnitude.

11490 HYPERFINE SPECTRUM OF CHROMIUM 53 IN Al_2O_3.
R.W.Terhune, J.Lambe, C.Kikuchi and J.Baker.
Phys. Rev. (USA), Vol. 123, No. 4, 1265-8 (Aug. 15, 1961).

Electron nuclear double-resonance techniques were used to observe the hyperfine spectrum of Cr^{53} in Al_2O_3. Through analysis of the spectrum at zero degrees a positive value of 48.5 ± 0.1 Mc/s was obtained for the hyperfine coupling constant and –0.85 ± 0.04 Mc/s for the quadrupole coupling constant. From this a value of –0.03 barn was deduced for the quadrupole moment of Cr^{53}.

11491 CROSS-RELAXATION EFFECTS IN MAGNETIC RESONANCE. N.Bloembergen.
Arch. Sci. (Switzerland), Vol. 13, No. Fasc. Spec., 361-4 (1960).

9th Colloque Ampère Paper (see Abstr. 4734 of 1961). A short review of the processes by which energy is transferred between different parts of a system of spins not spatially separated. Examples are taken from LiF, dilute paramagnetic salts and masers. D.J.Olive

11492 ADIABATIC PASSAGE AND TRANSIENT EFFECTS IN N.M.R. BY ROTATING COORDINATES.
G.Bonera, P.de Stefano and L.Giulotto.
Arch. Sci. (Switzerland), Vol. 13, No. Fasc. Spec., 365-70 (1960).
In French.

9th Colloque Ampère Paper (see Abstr. 4734 of 1961). Shows how rotating coordinates can be used in problems where relaxation and the effect of the oscillating field are considered simultaneously. D.J.Olive

11493 THEORY OF RESONANCE ABSORPTION OF ENERGY BY A ROTATING SOLID. J.Dreitlein and H.Kesseme
Phys. Rev. (USA), Vol. 123, No. 3, 835-52 (Aug. 1, 1961).

The theory of both nuclear resonance energy absorption and the relaxation of a coherent magnetization transverse to an applied external magnetic field is developed for nuclei in a mechanically rotating solid. The consequences of the formalism in the simple case of a solid composed of effectively isolated nuclear pairs is presented. For the more general nuclear lattice, a procedure for isolating and experimentally measuring the "exchange" interaction between the nuclei in the solid is proposed. Finally, the moments of the energy absorption line shape for the rotating solid are investigated and the second and fourth moments are explicitly calculated.

11494 THE KNIGHT SHIFT OF CADMIUM IN SOME ALLOYS WITH GROUP IB AND IIB METALS.
R.F.Grant and W.G.Henry.
Canad. J. Phys., Vol. 39, No. 6, 841-4 (June, 1961).

The Knight shift of the Cd^{111} and the Cd^{113} resonance in the primary solid solutions of silver, gold, magnesium, zinc, and mercury in cadmium has been investigated. The effect of the solute metal on the Knight shift of the solvent is discussed in terms of the charge displacements.

11495 STUDY OF THE NUCLEAR RESONANCE OF Fe^{57} IN THE LOCAL FIELD OF METALLIC IRON.
C.Robert and J.M.Winter.
Arch. Sci. (Switzerland), Vol. 13, No. Fasc. Spec., 433-5 (1960).
In French.

9th Colloque Ampère Paper (see Abstr. 4734 of 1961). The resonance of Fe^{57} in natural abundance was observed both in a slow passage experiment and by a spin-echo experiment. The latter verifies the inhomogneous nature of the line width, and shows that T_1 and T_2 are equal and decrease with increasing temperature, that the radiofrequency field is enhanced about 1500-fold in the Bloch walls, and that the signal is decreased by an external magnetic field. E.F.W.Seymou

11496 NUCLEAR MAGNETIC RESONANCE IN $(NH_4)_2(BeF_4)_x(SO_4)_{1-x}$ AND OTHER FERROELECTRIC SYSTEMS. G.Burns.
Phys. Rev. (USA), Vol. 123, No. 1, 64-6 (July 1, 1961).

The temperature dependence of fluorine and proton nuclear

gnetic resonance (n.m.r) in polycrystalline samples of the solid ution $(NH_4)_2(BeF_4)_x(SO_4)_{1-x}$ was measured for several values of This solid solution is ferroelectric for high and low x and is raelectric in between. A sharp transition in the second moment the F^{19} resonance was observed but found to be independent of x, ile the ferroelectric properties are dependent on x. The proton n.r. showed the nonequivalence of the NH_4 groups, but again the nperature dependence could not be correlated with the ferroelec- c properties. Thus, the ferroelectric behaviour of this system nnot be associated with the appealing hypothesis of the freezing in the vibrating NH_4 or BeF_4 groups. The temperature depend- ce of the proton n.m.r. was also observed in the ferroelectric mpounds $(NH_4)_2Cd_2(SO_4)_3$ and NH_4HSO_4. Similar conclusions can be awn from these measurements as those given above. In some of the ums, the crystallographic phase transition is again not accompanied any change in the proton resonance line. However, in N_2H_5Al um and NH_3OHAl alum, there is a very abrupt change in the n.m.r. ne at the temperature of the phase transition.

11497 THE DYNAMIC POLARIZATION OF PROTONS IN PARADICHLOROBENZENE IN A LOW FIELD.

..Landesman.

.rch. Sci. (Switzerland), Vol. 13, No. Fasc. Spec., 667-8 (1960).

1 French.

9th Colloque Ampère Paper (see Abstr. 4734 of 1961). Results btained indicate that an appreciable dynamic polarization is btained in a low magnetic field when the resonance frequency of he chlorine spins is increased by a quadrupolar interaction.

W.J.Orville-Thomas

11498 PROTON MAGNETIC RESONANCE IN PURE AND DOPED ICE. K.Kume.

J. Phys. Soc. Japan, Vol. 15, No. 8, 1493-50 (Aug., 1960).

Based upon a carefully designed method of measurement in samples showing long T_1, a complete proton magnetic resonance experiment is attempted. First, on a second moment argument in the rigid lattice state, the possibility that protons do not lie on the inter-oxygen lines is pointed out, in connection with the neutron diffraction studies. Secondly, from the relaxation time and line-narrowing measurements, the difference between the behaviours of protons in pure and doped ice is discussed, while the results of the dielectric and the direct current conductivity measurements by the Zurich group are taken into consideration.

POSSIBILITIES OF IMPROVING METHODS IN QUADRUPOLE RESONANCE. See Abstr. 10797

MECHANICAL PROPERTIES OF SOLIDS

A METHOD FOR GAUGE FACTOR DETERMINATION. See Abstr. 10467

11499 COMPACT APPARATUS FOR HIGH TEMPERATURE MODULUS OF RUPTURE MEASUREMENT.

P.T.B.Shaffer.

Rev. sci. Instrum.(USA), Vol. 32, No. 7, 794-5 (July, 1961).

By means of a compact graphite apparatus, modulus of rupture may now be determined at temperatures in excess of 2350°C. The design is such that the apparatus may be used in any furnace with a hot zone 4 in. in diameter by 6 in. high, protected by an inert atmosphere.

11500 DETERMINATION OF THE ELASTIC MODULUS OF CHROMIUM CARBIDE–NICKEL ALLOYS.

P.I.Mel'nichuk, V.N.Klimenko and A.B.Lyashchenko.

Fiz. Metallov i Metallovedenie (USSR), Vol. 9, No. 6, 918-21 (June, 1960). In Russian.

The concentration dependence of the elastic modulus, E, of the Cr_3C_2–Ni alloys, containing 5-40% Ni, was determined by the dynamic method. The extrapolated value of E of pure Cr_3C_2 was $E_k = 3.8 \times 10^6$ kg/cm². An empirical formula $E_C = E_k(1-0.0061\,K)$ was derived, where E_C is the value of E of an Cr_3C_2–Ni alloy containing K% Ni. M.H.Sloboda

11501 ELASTIC CONSTANTS OF TiC AND TiB_2.

J.J.Gilman and B.W.Roberts.

J. appl. Phys. (USA), Vol. 32, No. 7, 1405 (July, 1961).

The elastic constants were determined for speciments of TiC and TiB prepared by the arc fusion process. The velocities of transverse and longitudinal sound waves were measured in the <100> and <111> directions for cubic TiC and along the "c' and "a" axes for hexagonal TiB_2. Both materials have high elastic constants consistent with the high hardnesses. TiC is nearly isotropic elastically. An estimate of the surface energies for TiC yields a minimum value for the (100) planes (2500 erg/cm²) consistent with the observed cubic cleavage. A.E.Kay

11502 ELASTIC CONSTANTS OF SINGLE-CRYSTAL Y.I.G.

A.E.Clark and R.E.Strakna.

J. apply. Phys. (USA), Vol. 32, No. 6, 1172-3 (June, 1961).

The elastic constants and moduli of single-crystal yttrium iron garnet are calculated from results of ultrasonic velocity measurements using the phase interference method of McSkimin. From these results the Lamé constants and the bulk modulus are calculated for polycrystalline YIG. A comparison is made of known measured values for Young's modulus and ultrasonic velocities in polycrystalline YIG with the calculated values from single-crystal measurements. The calculated magnetostriction constant for polycrystalline YIG is about one order of magnitude smaller than the measured value reported previously. The authors conclude, therefore, that the dipole–dipole interaction does not appear to be large enough to account for the magnetostriction in YIG. W.G.Mayer

11503 PRESSURE DEPENDENCE OF THE ELASTIC SHEAR CONSTANTS OF Li. A.L.Jain.

Phys. Rev. (USA), Vol. 123, No. 4, 1234-8 (Aug. 15, 1961).

The elastic shear constants $C = C_{44}$ and $C' = \frac{1}{2}(C_{11} - C_{12})$ of lithium were measured as a function of pressure at room temperature. The measured values of $d \ln C/d \ln r$ and $d \ln C'/d \ln r$ are −4.1 and −2.8, respectively. This inequality of the two pressure variations is contrary to the situation found in sodium, where the two coefficients were equal. Theoretically, the two coefficients are expected to be the same, if only the electrostatic interaction between the electrons and the ions is responsible for the elastic stiffness of metal. The different behaviour in lithium can be understood in terms of the extra contribution to the shear constants arising due to the change in the Fermi energy of the electrons on shearing.

VOLUME AND SURFACE MAGNETO-ELASTIC WAVES IN METALS. See Abstr. 11444

11504 LOW-TEMPERATURE DISSIPATION PEAK IN NIOBIUM. P.G.Bordoni, M.Nuovo and L.Verdini.

Phys. Rev. (USA), Vol. 123, No. 4, 1204-6 (Aug. 15, 1961).

The energy dissipation coefficient Q^{-1} and the resonant frequency of a circular plate of niobium were measured as a function of temperature in the range 60-300°K. The measurements were carried out at four different frequencies from 18 kc/s to 174 kc/s with strain amplitudes smaller than 10^{-7}. For each vibration mode a pronounced peak is found for the dissipation coefficient while the frequency–temperature curves show a corresponding inflection. The temperature T_m of the dissipation peak depends on the vibration frequency according to an Arrhenius equation which characterizes the thermally activated relaxation effects. The activation energy $\overline{W}$ and the limiting relaxation time $\overline{\tau}_0$ of the process were computed and these values [$\overline{W} = 0.265$ eV and $(\overline{\tau}_0)^{-1} = 61 \times 10^{11}$ sec^{-1}] are in agreement with the values previously found in some f.c.c. metals for the relaxation effect due to the motion of dislocations. The value of $\overline{W}$ found in niobium shows that the effect cannot be directly produced by the motion of interstitial atoms of hydrogen.

11505 STRESS RELEASE IN PLASTICALLY DEFORMED SILVERCHLORIDE BY ANNEALING.

R.G.De Lange and W.G.Burgers.

Proc. K. Ned. Akad. Wetensch. B (Netherlands), Vol. 64, No. 3, 346-50 (1961).

It is shown that the reduction of the internal stresses in the individual crystallites of a trained silver chloride testpiece on annealing takes place at different rates. Single crystals recover at a faster rate than polycrystalline testpieces.

11506 THEORY OF THE DEFORMATION AND FRACTURE OF BODY-CENTRED CUBIC TRANSITION METALS.

A.A.Johnson.

Nature (GB), Vol. 189, 826-7 (March 11, 1961).

Inadequacies of Cottrell's theory of the ductile–brittle transition are discussed and a modified theory is presented which accounts for the discrepancies between experimental results and Cottrell's theory. An expression, representing the criterion for brittle fracture, is derived and it is shown that for a b.c.c. transi-

tion metal to be relatively brittle it must have both strongly locked dislocations and a high work-hardening rate. The transition temperature is practically independent of the grain size for brittle metals such as W and Mo, but is greatly affected by this factor in the case of ductile metals, such as Nb and steel. The new theory can be also used to re-interpret the experimental evidence on neutron radiation-induced hardness and brittleness of mild steel and Mo.

M.H.Sloboda

11507 MICROHARDNESS OF FERRITE IN CARBON STEELS. Yu.E.Bondarev.
Fiz. Metallov i Metallovedenie (USSR), Vol. 10, No. 2, 308-9 (Aug., 1960). In Russian.

In connection with problems of phase separation and stress development, the microhardness of ferrite grains in four steels is determined and shown to increase with carbon content of the steel.

R.F.S.Hearmon

11508 FEATURES OF MECHANICAL PROPERTIES OF LITHIUM RELATED TO LOW-TEMPERATURE POLYMORPHIC TRANSITIONS.
I.A.Gindin, B.G.Lazarev and Ya.D.Starodubov.
Fiz. Metallov i Metallovedenie (USSR), Vol. 10, No. 3, 472-80 (Sept., 1960). In Russian.

Reports a study of mechanical properties of lithium under tensile loads at 1.5°-300°K. The presence of two or three modifications affected plasticity, uniformity of deformation, work hardening and microhardness. Transitions between these modifications were produced by changes of temperature or by plastic deformation.

A.Tybulewicz

11509 THE HARDENING OF A RIGID–PLASTIC MATERIAL. Khuan Ké-Chzi [Huang K'o-Chih]..
Priklad. Mat. i Mekh. (USSR), Vol. 22, No. 4, 544-6 (1958). In Russian.

The Tresca flow conditions are represented by a hexagonal prism in stress space, and the effects of various deformation laws on the prism are tabulated.

R.F.S.Hearmon

11510 ON TEMPERATURE CHANGE INVESTIGATION DURING THE PLASTIC DEFORMATION OF FACE-CENTRED CUBIC METALS. P.Derner and E.Kappler.
Z. Phys. (Germany), Vol. 163, No. 1, 62-70 (1961). In German.

Measurements at different temperatures (+20°C and −195°C) on polycrystalline and single-crystal face-centred cubic metals revealed a reversible and an irreversible change of yield point. The first was independent of purity, grain size and speed of deformation. The second (the "work-softening" effect) depended on the degree of deformation at low temperature.

J.Thewlis

THE EFFECT OF PLASTIC DEFORMATION ON THE STRUCTURE AND PROPERTIES OF AN ALUMINIUM–MAGNESIUM ALLOY. See Abstr. 10266

11511 ORDINARY WAVES IN AN INDEFINITE ELASTO-PLASTIC MEDIUM. J.Mandel.
C.R. Acad. Sci. (France), Vol. 252, No. 15, 2174-6 (April 10, 1961). In French.

Shows that in an elastoplastic medium, which in the limit is in the state of plastic flow, there exist (for all directions of the normal to a wave-front) three velocities corresponding to the three rectangular components of the vector of acceleration discontinuity. Relates these velocities to the corresponding velocities of elastic waves.

J.K.Skwirzynski

11512 THE MOVING DISCONTINUITY SURFACES IN AN INDEFINITE ELASTOPLASTIC MEDIUM. J.Mandel.
C. R. Acad. Sci. (France), Vol. 252, No. 17, 2505-7 (April 24, 1961). In French.

Continuation of previous work (see preceding abstract), particularly extending the results to moving surfaces of discontinuity (elastic → plastic) of higher orders. The relations between velocities of the discontinuity in question and corresponding velocities of elastic waves are the same for surfaces of the second and of third orders.

J.K.Skwirzynski

11513 CREEP OF CYLINDERS IN TORSION. R.V.Hesketh.
Brit. J. appl. Phys., Vol. 12, No. 7, 349-50 (July, 1961).

11514 EFFECT OF IRRADIATION GROWTH ON THE CREE OF URANIUM UNDER A UNIAXIAL LOAD. W.S.Blackburn.
Phil. Mag. (GB), Vol. 6, 503-8 (April, 1961).

Theories are developed from two different assumptions to calculate the effect of irradiation growth on the creep of uranium under a uniaxial applied stress when the temperature is sufficien high for the internal stresses set up by the differential expansion of the individual crystals to be insufficient of themselves to caus plastic flow. It is shown that the greater the irradiation growth t greater is the creep rate for a given stress; the effect on creep rate is also greater at lower applied stresses for a given irradiati growth.

11515 THE EFFECT OF COMPOSITION OF MAGNESIUM–ALUMINIUM SOLID SOLUTIONS OF α-TYPE ON SLIP LINES. V.I.Syutkina and É.S.Yakovleva.
Fiz. Metallov i Metallovedenie (USSR), Vol. 10, No. 3, 481-6 (Sept., 1960). In Russian.

Reports that the effect of increasing Mg concentration on slip lines is different in the initial stages of deformation from the effe when deformations are large. The effect of Mg is explained in terms of work-hardening of the slip regions at the beginning of extension and in terms of softening of these regions when the deformation is considerable.

A.Tybulewi

11516 DETERMINATION OF THE SLIP ELEMENTS BY AN ANALYSIS OF THE ASTERISMS OF THE LAUE SPOT AND THE MODES OF DEFORMATION OF BERYLLIUM AT HIGH TEMPERATURES. P.Pointu, P.Azou and P.Bastien.
C.R. Acad. Sci. (France), Vol. 252, No. 13, 1984-6 (March 27, 196 In French.

Certain asterisms of the Laue spots are supposed to arise fr lattice rotations about the Taylor axis (that is, an axis in the slip-plane perpendicular to the slip direction). The authors have verif this for the hexagonal metals and have determined several new deformation modes of beryllium at high temperatures.

R.Bullou

11517 CHANGE IN MODULUS OF RIGIDITY OF BRASS WIRES BY COLD-WORKING AND SUBSEQUENT ANNEALING. J.Kuroyanagi.
J. Phys. Soc. Japan, Vol. 15, No. 8, 1386-95 (Aug., 1960).

The change was measured on wires containing 10.14, 30.15 an 40.24% zinc and a commercial brass wire (32.66% zinc), and compared with that of pure copper wire. The results showed that (1) in the well annealed state, the modulus of rigidity of brass wir decreases quasi-linearly with the increase of zinc content, (2) the modulus of rigidity of a brass wire always decreases with the increase of the degree of cold-working, but the relative decrease the modulus of rigidity, compared with the decrease for a pure copper wire equally cold-worked, differs according to the zinc content and (3) the variations in the temperature coefficient of the modulus of rigidity with the method of cold-working and with the degree of cold-working have characteristics according to the zinc content.

11518 LONG TERM STRENGTH AND STATIONARY CREEP OF POLYCRYSTALLINE MATERIALS. A.N.Orlov.
Fiz. tverdogo Tela (USSR), Vol. 3, No. 2, 500-4 (Feb., 1961). In Russian.

For abstract, see Abstr. 10222 of 1961. [English translation in: Soviet Physics - Solid State (USA), Vol. 3, No. 2, 367-9 (1961)].

11519 FEATURES OF THE DEVELOPMENT OF FRACTURE CRACKS IN SOLID POLYMERS.
M.I.Bessonov and E.V.Kuvshinskii.
Fiz. tverdogo Tela (USSR), Vol. 3, No. 2, 607-10 (Feb., 1961). In Russian.

Using a method of controlled rupture (Abstr. 4820 of 1957) optical observations are reported on fracture cracks in methyl methacrylate + 6% butyl phthalate. The interference patterns are reproduced and discussed in general terms. [English translation Soviet Physics — Solid State (USA)].

R.F.S.Hearm

11520 FRICTION AND ADHESION OF CLEAN AND CONTAMINATED MICA SURFACES. A.I.Bailey.
J. appl. Phys. (USA), Vol. 32, No. 8, 1407-12 (Aug., 1961).

In order to determine the shear strength of boundary lubrican it is essential to use a substrate which is smooth on a molecular scale. An apparatus is described in which it is possible to apply normal and tangential loads to sheets of mica covered with mono-molecular layers of boundary lubricant. The shear strength

ined from these experiments explains in part why frictional e and pickup are not reduced proportionately, in the presence boundary lubricant. The remaining difference is probably due astic hysteresis losses in the sliding solids. The surface gy of mica in air has also been measured by determining the e necessary to propagate a crack in the material. Cycles of ing and closing the crack have been performed and the differ- in energy which is observed is attributed to the adsorption migration of an interfacial film of air or water vapour. An tronmicrographic study of the structure of monolayers deposited etraction from nonpolar solution is also described. This indi- s that the area covered by the monolayer is only about $\frac{1}{3}$ the l surface area. This poor coverage arises from incorporation solvent molecules in the monolayer, which later evaporate.

11521 RECENT WORK ON SOLID FRICTION AT THE RESEARCH LABORATORY FOR THE PHYSICS AND EMISTRY OF SOLIDS. A.I.Bailey.
appl. Phys. (USA), Vol. 32, No. 8, 1413-19 (Aug., 1961).

A review of some recent work done in the Research Laboratory the Physics and Chemistry of Solids, University of Cambridge. ree main topics are discussed as follows. (a) The friction and ar of materials at very high rates of sliding. When a ball, inning at high velocity, is brought into contact with a flat surface a material such as bismuth, very rapid wear occurs as a result melting on a large scale. For this to occur, the material should ve a low melting point and a low thermal conductivity, as these operties together influence the rate at which the melted zone netrates the solid. (b) Elastic hysteresis losses and rolling ction. A cylinder rolling over the surface of rubber causes the aterial under the roller to be subjected to a complex deformation cle, partly torsion and partly tension. Experiments to investigate e hysteresis losses in such complex cycles are described and ed in the interpretation of rolling friction results. (c) The effect combined stresses and contamination on the growth of junctions tween metal surfaces. The simple theory of friction treats the ean yield pressure and the maximum shear stress as independent rength properties. Plasticity theory suggests that the yielding a junction should occur as the result of their combined action. he theory has been confirmed by experiment and used to explain e fact that small traces of contamination can reduce the very high lues of friction observed with outgassed metals to normal values 1 or 2.

11522 SINGLE CONTACTS AND MULTIPLE ENCOUNTERS. J.F.Archard.
. appl. Phys. (USA), Vol. 32, No. 8, 1420-5 (Aug., 1961).

The analysis of wear experiments suggests that most of the vents which occur in rubbing are contacts between protuberances hich are deformed elastically and which separate without damage; n asperity encounter with damage is a relatively rare event. Apparatus for the study of isolated single contacts is described. A single contact which is deformed elastically does not obey Amontons's law, but an assembly of such contacts (multiple contact conditions) should do so. It is shown that under multiple contact conditions the load which can be borne by elastic deformation of the protuberances may be as much as a million times larger than that which can be borne by each individual asperity contact. Reflection electron microscopy shows that many irregularities on worn surfaces must bear their share of the load without plastic flow. Recent experiments suggest that, although a worn particle is produced very infrequently, it is nevertheless the direct consequence of the many preceding encounters which occurred without apparent damage.

11523 FRICTION OF METALS IN RECIPROCATING SLIDING. Y.Tamai.
J. appl. Phys. (USA), Vol. 32, No. 8, 1437-40 (Aug., 1961).

A number of experiments were conducted on the metallic friction in reciprocating sliding with a pendulum. It was shown that the reciprocating sliding gives quite different results from those of single-traverse or uni-directional repeated sliding, which were emphasized in both the coefficient of friction and the electric contact resistance, surface damage due to sliding, and the low friction phenomenon.

11524 INFLUENCE OF SURFACE ENERGY ON FRICTION AND WEAR PHENOMENA. E.Rabinowicz.
J. appl. Phys. (USA), Vol. 32, No. 8, 1440-4 (Aug., 1961).

A number of friction and wear phenomena are explicable in terms of the surface energy of adhesion of the contacting materials. In the friction field, it is found qualitatively that high friction coefficients are found for sliding materials with high surface energy/hardness ratios and conversely. Unfortunately, it is not easy to test this relationship quantitatively because the derived expression contains parameters which cannot be independently controlled. However, in the wear field, it has been found possible to derive an expression for the size of loose wear particles which can be readily tested; namely, that the average size of loose wear particles is proportional to the surface energy hardness ratio, the nondimensional constant of proportionality being 60 000. Experiments with 15 different materials show the validity of this expression. Another phenomenon, adhesion, which also seems to be governed by surface energy considerations, is discussed in qualitative terms.

11525 MEASUREMENT OF FRICTION BETWEEN RUBBER-LIKE POLYMERS AND STEEL. D.I.James.
J. sci. Instrum. (GB), Vol. 38, No. 7, 294-9 (July, 1961).

A machine for measuring the coefficient of friction between a flat sheet of polymeric material and a ground steel plate is described in detail. An inverted lathe cross slide forms the basis of the drive mechanism. Frictional force is balanced against the tension developed in a spring (proof ring), the extension of which, measured with a commercial displacement pick-up, gives a direct reading of coefficient of friction. A few results are given for a PVC sample plasticized with 40% di-octyl phthalate. A circuit for automatic operation and recording is also described.

11526 ROLLING FRICTION OF POLYMERIC MATERIALS. II. THERMOPLASTICS. D.G.Flom.
J. appl. Phys. (USA), Vol. 32, No. 8, 1426-36 (Aug., 1961).

For Pt I see Abstr. 4572 of 1960. The results of rolling friction studies of several thermoplastics provide additional evidence for the correlation of such friction with dynamic mechanical losses in polymeric materials. Among the polymers discussed are polymethyl methacrylate, polytetrafluoroethylene, nylon, polyvinyl chloride, polyvinyl acetate, and polystyrene. The effects of spin and other deviations from pure rolling are demonstrated for polymethyl methacrylate, polytetrafluoroethylene, and nylon by varing the experimental parameters. In essentially pure rolling, the dependence of friction on temperature illustrates the importance of the extent of crystallinity in polytetrafluoroethylene, the amount of branching in polyethylene, and the concentration of plasticizer in polyvinyl chloride. In the latter effect, it is found that the temperature at which the rolling friction goes through a maximum varies linearly with plasticizer content.

STRUCTURE OF SOLIDS

11527 ON SOME THERMODYNAMIC PROPERTIES OF A SOLID PHASE OF GALLIUM UNSTABLE AT ATMOSPHERIC PRESSURE. A.Defrain and I.Epelboin.
J. Phys. Radium (France), Vol. 21, No. 1, 76-7 (Jan., 1960). In French.

The following properties are reported for gallium II at atmospheric pressure: freezing point $-16.3 \pm 0.2^{\circ}$C, latent heat 9.09 ± 0.03 cal/g, density (at -22°C) 6.23 g/cm^3. H.Mykura

CRYSTALLOGRAPHY

11528 SURFACE ORIENTATION AND FRICTION OF GRAPHITE, GRAPHITIC CARBON AND NON-GRAPHITIC CARBON. J.W.Midgley and D.G.Teer.
Nature (GB), Vol. 189, 735-6 (March 4, 1961).

Surface orientation of rubbed samples was studied by electron diffraction. In the case of non-graphitic carbon it appears that surface preferred orientation is due mainly to removal of crystals in other orientations. A.R.Stokes

CONTRIBUTION TO THE STUDY OF THE ORIENTATION OF SILVER ON SODIUM CHLORIDE. See Abstr 10280

11529 INTERPRETATION OF TWINNING DIAGRAMS OBTAINED BY ELECTRON DIFFRACTION. M.Gillet and E.Gillet.
C.R. Acad. Sci. (France), Vol. 252, No. 15, 2200-2 (April 10, 1961). In French.

Silver layers deposited on sodium chloride exhibit the pheno-

menon of twinning. This is manifested in the appearance of multiple spots on an electron diffraction pattern, and the full interpretation of these depends on postulating the occurrence of double diffraction in the basic and twinned layers. A.E.I.Research Laboratory

11530 STUDY ON THE TWIN FORMATION IN EVAPORATED SILVER FILMS. A.Nagasawa and S.Ogawa.
J. Phys. Soc. Japan, Vol. 15, No. 8, 1421-5 (Aug., 1960).

Well oriented silver films were formed by evaporation onto heated cleavage (001) surfaces of rock-salt in a vacuum, the evaporation period being varied over a wide range, while the thickness was kept at about 400 A, and the influence of the formation speed on the twinning in the films was examined by electron diffraction and electron microscopy. The diffraction patterns show that the frequency of the twin formation is not seriously decreased by the lowest formation speed, but that imperfections such as bending or twisting of the films are largely decreased. The interference fringes caused by the dynamical effect were observed on the electron micrographs of slowly formed films. This means that the slow formation of films also decreases imperfections such as dislocations and vacancies and makes the lattice more perfect. The fringes are believed to be so-called equal thickness fringes originated from wedges due to the twin formation.

11531 MICRO-DISK PATTERNS ON DIAMOND DODECAHEDRA. D.C.Pandeya and S.Tolansky.
Proc. Phys. Soc. (GB), Vol. 78, Pt 1, 12-16 (July, 1961).

An account is given of microscopic and interferometric studies on slightly raised disk formations which appear on the dodecahedral faces of several diamonds. One small diamond exhibits more than a thousand such disks on its faces. Interferometry shows that the disks are slight elevations. It is conjectured that they owe their origin to a protective action of small bubbles. Evidence is given that the crystals showing the disks were subjected to a solution or etch mechanism in the final stages of the crystal formation. The suggested micro-bubbles adhering to the surface would locally prevent dissolution, leaving ultimately slightly raised disks on the surface. By postulating the possibility of slight movement or oscillation of the conjectured bubbles, most of the observed complex topographical features of the disks can be accounted for.

11532 POINT DEFECTS IN CALCITE CRYSTALS. I. INFORMATION ON ETCH SENSITIVE POINT DEFECTS AND THEIR DIFFUSION ON UNTREATED CLEAVAGE SURFACES OF RHOMBOHEDRAL CALCITE. I.Hanke.
Acta phys. Austriaca, Vol. 14, No. 1, 1-21 (1961). In German.

The diffusion and surface density of defects on an untreated cleavage surface of rhombohedral calcite were determined by means of etching. Three types of etch pit were distinguished. The dependence of the etching rate on the acid concentration was measured. A detailed study of the step formations in the etch pits was undertaken using interferometry techniques. A.J.Fox

11533 DISLOCATION ETCH PITS ON A- AND B-FACES OF GASH CRYSTAL. T.Nakamura and K.Ohi.
J. Phys. Soc. Japan, Vol. 15, No. 7, 1348-9 (July, 1960).

Describes the form of the etch pits on chemically cut faces of guanidinium aluminium sulphate hexahydrate crystals. (See Abstr. 20818 of 1960). D.G.Holloway

DISLOCATION ETCH-PITS IN CdS. See Abstr. 11213

11534 ENANTIOMORPHOUS CHARACTER OF ETCH PITS IN TELLURIUM. J.S.Blakemore and K.C.Nomura.
J. appl. Phys. (USA), Vol. 32, No. 4, 745-6 (April, 1961).

A brief comment on the relationship between the form of etch pits and the optical activity of tellurium. The two shapes which can be produced are mirror images of each other and cannot be made congruent by rotation. A.E.Kay

11535 THE INFLUENCE OF ELASTIC-RELAXATIONAL STRESSES ON THE CRYSTALLIZATION OF A VERY VISCOUS LIQUID. L.V.Tverskaya.
Dokl. Akad. Nauk SSSR, Vol. 137, No. 5, 1095-7 (April 11, 1961). In Russian.

A formula is derived for rate of crystal growth allowing for stress relaxation processes during crystallization. [English translation in: Soviet Physics – Doklady (USA)]. R.F.S.Hearmon

11536 PRODUCTION OF SINGLE CRYSTALS FROM THE MELT IN CONDITIONS OF A SHARP TEMPERATUR DROP. I.V.Stepanov, M.A.Vasil'eva and N.N.Sheftal'.
Kristallografiya (USSR), Vol. 5, No. 2, 334-5 (March-April, 1960 In Russian.

Crystals were grown in a furnace which allowed superheatin of the melt and forced cooling of the crystal. High rates of grow were realized and the spontaneous purification of the material w increased. [English translation in: Soviet Physics—Crystallography (USA), Vol. 5, No. 2, 315-16 (Sept.-Oct., 1960)]. D.G.Hollo

CRYSTAL GROWTH OF METALLIC OR METALLIC-OXIDE SMOKE PARTICLES PRODUCED BY ELECTRIC ARCS. See Abstr. 11563

11537 SYNTHESIS OF AlN CRYSTALS. T.Matsumura and Y.Tanabe.
J. Phys. Soc. Japan, Vol. 15, No. 1, 203 (Jan., 1960).

AlN crystals, grown by the Frerichs technique, in which Al vapour was reacted with N_2 at 1500°C, were deposited at 1450°C as colourless rods 4 × 0.1 × 0.1 mm and plates 1 mm^2. AlN crys were also grown at 1200°C, by heating AlN powder to 1500°C; th crystals were smaller than those obtained by the Frerichs meth J.Fra

11538 ELECTRON MICROSCOPIC EVIDENCE FOR THE SPIRAL GROWTH OF DENDRITES. W.Hinz and W.Skatulla.
Naturwissenschaften (Germany), Vol. 48, No. 8, 300-1 (1961). In German.

A lithium glass was tempered for about 2 hours at 625°C aft which its fracture surfaces were studied by taking carbon replic The dendritic branches appear to consist of several crystal stra which are spirally wound. R.R

11539 SOME DISTINGUISHING FEATURES OF CRYSTAL GROWTH IN FERRITES HAVING THE GARNET STRUCTURE. V.A.Timofeeva.
Kristallografiya (USSR), Vol. 5, No. 3, 476-7 (May-June, 1960). In Russian.

Some observations on the crystal habit of the rare-earth ferrites grown from solution in PbO are reported. [English tran lation in: Soviet Physics—Crystallography (USA), Vol. 5, No. 3, 453-6 (Nov.-Dec., 1960)]. D.G.Hollo

11540 RIBBON-LIKE CRYSTALS OF SELENIUM GROWN FROM VAPOUR. N.Furuta.
J. Sci. Hiroshima Univ. A (Japan), Vol. 24, No. 2, 327-38 (Oct., 1

The shapes of metal Se crystals grown by condensation from the vapour as a function of the ratio of supersaturation in the va were studied, and also the effect of illumination on the shapes an the growth rates of the crystals. Two forms of crystal grower a described, the one suitable for observation of the crystals by me of an optical microscope and the other for observation by means an electron microscope. Most of the crystals have a ribbon-like shape with the $(10\bar{1}0)$ plane and spines extending parallel to the [0001] axis. The crystallographic orientation depends on the ra of supersaturation. The growth rate changes with the illuminati dependent mainly on the intensity and only slightly on the wavele of the light used. S.Weint

11541 THE AGGREGATION OF SMALL ICE CRYSTALS. C.L.Hosler and R.E.Hallgren.
Disc. Faraday Soc. (GB), No. 30, 200-7 (1960).

The growth of small aggregates of ice crystals was observe between −6°C and −25°C by mounting an ice sphere in a moving cloud of ice crystals. The density of the aggregate formed increased with increasing temperature, and observations of the aggregate growth showed that the bonds between ice-crystals permit folding of crystal towers. The higher the temperature, more folding was noted. The proportion of the ice-crystals in t path of the aggegate that became attached to it was temperature-dependent, showing a maximum collection efficiency at −11°C. Plates formed aggregates at a greater rate than did columnar crystals; hence, when the cloud composition changed from plate to columns as the temperature increased above −11°C, the amou of aggregation diminished. These data and other evidence are interpreted as indicating that the aggregation of the ice-crystals depends upon the existence of a liquid film on the ice-surfaces. The film thickness is greater at higher temperature.

1542 INVESTIGATION OF ACTIVATOR DISTRIBUTION IN NaI:Tl CRYSTALS.
.Belikovich, V.N.Výshnevskýi, O.B.Lýskových and .Pidzyrailo.
ayin. fiz. Zh. (USSR), Vol. 4, No. 1, 108-15 (1959). In Ukrainian.
The crystals were grown from a melt by a modification of opoulos's method. Along with the regulated lateral heater, the nace contained an independently regulated bottom heater. stals of about 40 mm in diameter and length were taken for centration investigations. The thallium concentration in ious regions of the grown crystals was determined (employing ctrophotometric method) by the absorption intensity at the ximum of the long-wave absorption band of the activator. The ivator content of the crystals proved to be 7-12 times less than t of the charge. Thallium is distributed somewhat unevenly ough the crystal volume: the later the crystal region is formed he growth process, the lower the thallium content. The gitudinal and radial concentration gradients do not, in general, eed 10% per cm. In some crystal zones the activator distribun is practically uniform in the radial direction. The latter t evidently indicates that on applying a regulated bottom ater in the crystal growing furnace, such thermal conditions y be created that the crystal growth front acquires the most vantageous form from the standpoint of uniformity of activator tribution in the crystal. The presence of a relatively small ncentration gradient in the investigated crystals indicates that nost the entire effective volume of the crystals grown by the plied method may be utilized as a scintillator.

11543 CONCERNING THE GROWTH OF CRYSTALS OF INTERMETALLIC COMPOUNDS IN THE Zn–Sb, l–Sb, AND In–Sb ALLOY SYSTEMS. V.I.Psarev.
istallografiya (USSR), Vol. 5, No. 3, 479-81 (May-June, 1960). Russian.
The growth of crystals of the compounds in the corresponding olten alloy was studied. Rotation of the crucible containing the loy (at 500-2000 r.p.m.) produced larger crystals. [English anslation in: Soviet Physics–Crystallography (USA), Vol. 5, o. 3, 459-62 (Nov.-Dec., 1960)]. D.G.Holloway

11544 USEFUL TECHNIQUE FOR GROWING LARGE, SINGLE-CRYSTAL YIG. D.Barry and R.W.Roberts.
appl. Phys. (USA), Vol. 32, No. 7, 1405 (July, 1961).
Description of a method to get large crystals from a relatively nall crucible by recharging it after melting and cooling. H.E.Schmid

11545 COLD HEARTH ZONE REFINING. R.M.Ware.
J. sci. Instrum (GB), Vol. 38, No. 4, 166 (April, 1961).
A water cooled copper hearth arranged to run inside a silica be was used to purify cobalt silicides. Induction heating was used melt the compound and pick-up of copper from the hearth is egligible. Figures for impurity content of an ingot of cobalt isilicide after 8 and 14 passes show the effectiveness of the ethod. W.Bardsley

11546 AN IMPROVEMENT TO THE FLOATING ZONE METHOD OF GROWING SINGLE CRYSTALS.
i.W.Green.
. sci. Instrum. (GB), Vol. 38, No. 4, 167 (April, 1961).
The improvement is to rotate the ends of the rod at the same ate, but in opposite directions, about the molten zone. This echnique maintains the straightness of the rod for an indefinite umber of passes and will also correct any departure from straightess. The experimental arrangement is described. W.Bardsley

11547 THE INFLUENCE OF AN ELECTRIC FIELD ON THE GROWTH OF COPPER WHISKERS.
T.Hofman, J.Mazur, J.Nikliborc and J.Rafałowicz.
Brit. J. appl. Phys., Vol. 12, No. 7, 342-3 (July, 1961).
The influence of an electric field on the growth of copper whiskers obtained by Brenner's method was studied. There is a marked directional tendency during the growth process and it is thought that ions may play a part in the phenomenon.

11548 ELECTRON INTERFEROMETER STUDIES OF IRON WHISKERS.
H.A.Fowler, L.Marton, J.A.Simpson and J.A.Suddeth.
J. appl. Phys. (USA), Vol. 32, No. 6, 1153-5 (June, 1961).
Electron interference patterns were obtained using an iron whisker as the electrostatic fibre of a Möllenstedt interferometer (Abstr. 5922 of 1956). The tilted fringes in the shadow pattern resemble those observed by Chambers (Abstr. 19760 of 1960) and show the relationship between flux leakage and geometrical shape of the whisker. Chambers' general model of the flux configuration is confirmed.

11549 TWIST IN ALUMINA WHISKERS.
G.W.Sears, R.C.DeVries and C.Huffine.
J. chem. Phys. (USA), Vol. 34, No. 6, 2142-3 (June, 1961).
Eshelby twists (Abstr. 3518 of 1958) were microscopically observed at the tapered tips of alumina whiskers grown by the reaction

$$Al_2O(g) + 2H_2O(g) \rightleftharpoons 2H_2(g) + Al_2O_3(s).$$

It was found that the twist and associated screw dislocation could be removed by nonuniform bending occurring during breakage of the whisker from its base.

CRYSTAL LATTICE STRUCTURES

11550 CONFERENCE ON THE PRECISION DETERMINATION OF LATTICE PARAMETERS (STOCKHOLM, 9-12 JUNE, 1959).
Acta cryst. (Internat.), Vol. 13, Pt 10, 818-50 (Oct., 1960).
This conference was organized by the International Union of Crystallography; it was held on 9-12 June, 1959. Only some of the papers presented were submitted to "Acta Crystallographica" and abstracts of these will be found under the appropriate headings in this or subsequent issues of Physics Abstracts.

11551 A REMOTELY CONTROLLED NEUTRON DIFFRACTOMETER BASED ON A GUR – 3 UNIT.
R.P.Ozerov, S.V.Kiselev, I.R.Karpovich, V.I.Goman'kov and A.A.Loshmanov.
Kristallografiya (USSR), Vol. 5, No. 2, 317-19 (March-April, 1960). In Russian.
Describes the modifications made to a standard X-ray goniometer to permit its use as a neutron diffractometer. The specimen table and counter are separately moveable, the angles being read by selsyns. The instrument is not designed to carry heavy loads and separate shielding is employed. Counting is automatic but the angles of reflection cannot be read directly from the recorder although they can be deduced. [English translation in: Soviet Physics – Crystallography (USA), Vol. 5, No. 2, 294-6 (Sept.-Oct., 1960)]. J.Thewus

11552 IMPROVED ATTACHMENT FOR HIGH TEMPERATURE SINGLE-CRYSTAL X-RAY WORK.
A.Barclay and J.D.Donaldson.
J. sci. Instrum. (GB), Vol. 38, No. 7, 286-7 (July, 1961).
This attachment to an X-ray goniometer permits single-crystal or powder photographs to be taken using copper radiation up to 900° C. The alignment of the heating element can be checked and altered while the attachment is in use, and the apparatus does not have to be cooled before each film is developed.

11553 LATTICE PARAMETER DETERMINATIONS WITH AN X-RAY SPECTROGONIOMETER BY THE DEBYE–SCHERRER METHOD AND THE EFFECT OF SPECIMEN CONDITION. H.M.Otte.
J. appl. Phys. (USA), Vol. 32, No. 8, 1536-46 (Aug., 1961).
It is shown that the Debye–Scherrer method can be used successfully on an X-ray spectrogoniometer by removing the bisecting mechanism. Complete profiles of the diffraction lines were recorded and the centre of gravity (CG) determined with an accuracy of $\pm 0.005^\circ 2\theta$. Monochromated CuK_α radiation was employed and the complete X-ray unit housed in a room maintained at constant temperature to within $\pm 1^\circ$C. The lattice constant was calculated from each reflection and plotted against the Nelson–Riley function; a straight line could be drawn through all the points. The limiting factors in the accuracy of the lattice constant determination are the uncertainties in the correction for vertical divergence, monochromatization, and tail effects in measuring the CG (and in the X-ray wavelength). Solid rods as well as compacts made of filings were examined after annealing and after deformation. The lattice constant of pure Al was found to be unaffected (within ±0.00005 A) by the condition in which it was examined, contrary to observations by certain other investigators. However, the lattice constants of single-phase alloys are in general quite sensitive to their state of preparation. The influence of short-range ordering, stacking faults, solute clustering, quenching stresses, etc. are discussed and their relative importance assessed.

11554 THE QUESTION OF THE PRECISION MEASUREMENTS OF LATTICE PARAMETERS. (DETERMINATION OF THE TUNGSTEN PARAMETER).
M.M.Umanskii, V.V.Zubenko and Z.K.Zolina.
Kristallografiya (USSR), Vol. 5, No. 1, 51-5 (Jan.-Feb., 1960).
In Russian.

A sample of the tungsten used in the recent international investigation by the Commission on Crystallographic Apparatus of the International Union of Crystallography was obtained. RKU95 and RKU114 cameras were used, specially checked for accuracy of radius and centring. They were accommodated in an air thermostat stabilized to 0.2°C. Very small beam divergences were used. The powder specimens were contained in 0.1 mm diameter celluloid tubes. A large number of observers measured two X-ray patterns to ascertain the accuracy of determination of the reflection angles. The tungsten lattice Debye pattern was obtained using Cu, Ni, Co, W and Fe radiations, at a specimen temperature of 25°C. Lines for $\theta > 55°$ were measured by several observers, and results extrapolated to $\theta = 90°$; the least squares extrapolation method was employed, weighting points according to the value $I \tan\theta$, where I is the relative intensity on a five-point scale. Radiation angles were corrected for refraction errors. The mean value of the tungsten parameter was found to be 3.16524 ± 0.00005 A. A table is given to show the variation of the parameter for the various radiations used. [English translation in: Soviet Physics—Crystallography (USA), Vol. 5, No. 1, 43-7 (July-Aug., 1960)].
R.V.Coates

11555 EXTINCTION IN X-RAY CRYSTALLOGRAPHY.
S.Chandrasekhar.
Advances in Phys. (GB), Vol. 9, 363-86 (Oct., 1960).

A survey is made of the theory of primary and secondary extinction, and of methods of correcting observed intensities for the effects of extinction; it deals, in particular, with the author's method, in which measurements of integrated intensity of reflection are made for two or more directions of polarization of the incident beam [see Acta Cryst. (Internat.), Vol. 9, 954 (1956); Vol. 13, 588 (1960)].
A.R.Stokes

11556 THE CHARACTERISATION OF LATTICE DISTORTION SPECTRA WITH DEFORMATION INDICES.
I.S.Szántó.
Acta tech. Hungar., Vol. 32, No. 1-2, 65-92 (1961).

Criticizes the common procedure of deriving stress from the change in average lattice spacing obtained from X-ray line shift, and proposes instead some indices of deformation depending on line shift and line breadth. A practical example (on stressed steel) illustrates their use.
A.R.Stokes

11557 X-RAY LINE BROADENING FROM THE POLISHED SURFACES OF SILVER AND GOLD. M.Kuriyama.
J. Phys. Soc. Japan, Vol. 15, No. 8, 1426-33 (Aug., 1960).

The linear relation (Hall's formula) and the quadratic relation between the integral breadth and the scattering angle can be derived from the general formula for intensity distribution by the assumption of the appropriate distribution for both size and strain. The use of these two formulae (line breadth method) can give not only the magnitude but also the plausible distribution for strain and size. The advantage of this method is that the magnitude and the distribution of size and strain can be obtained separately, in contrast with the Fourier analysis of line profile (line profile analysis method). The line breadth method is applied to the polished surfaces of Ag and Au and the results obtained are confirmed to be correct by the line profile analysis. On the other hand, it is possible to use the fine profile analysis to study the strain variation with the depth in specimens, as long as only one kind of radiation is used. This strain variation can be observed by the line breadth method with the use of different radiations, and the comparison is made between the results from the line breadth method and from the line profile analysis method.

11558 CONCERNING THE STUDY OF FINE STRUCTURE OF CRYSTALS FROM THE INTENSITIES OF THE DIFFRACTION LINES. L.V.Tikhonov.
Kristallografiya (USSR), Vol. 5, No. 2, 194-9 (March-April, 1960).
In Russian.

When a polycrystalline alloy consists of crystallites of the size 10^{-5}-10^{-3} cm, ageing cannot be detected from the width of the diffraction lines. Hence, the applicability to such alloys of the method for determining the size of the crystallites and distortions of order III from the integrated intensities of the diffraction lines was analysed, taking into account primary extinction. It is shown that such a determination for any phase of the alloy is possible, and formulae are obtained from which the calculations may be carried out. [English translation in: Soviet Physics—Crystallography (USA), Vol. 5, No. 2, 180-5 (Sept.-Oct., 1960)].
R.V.Coates

11559 IMAGINARY PART OF X-RAY SCATTERING FACTOR FOR GERMANIUM. COMPARISON OF THEORY AND EXPERIMENT. B.W.Batterman.
J. appl. Phys. (USA), Vol. 32, No. 6, 998-1001 (June, 1961).

The imaginary part of the X-ray scattering factor for germanium is calculated from dispersion theory and individual Hartree–Fock electron scattering factors and is compared with Hunter's experimental values (Abstr. 8912 of 1959) measured with anomalously transmitted X-rays. The agreement is quite good and verifies the treatment of anomalous transmission by the dynamical theory of diffraction. It is shown that the imaginary part of the scattering factor can be related directly to the form factor of the L electrons in germanium and it is concluded that their charge distribution in the solid is essentially the same as in the free atom.

11560 ATOMIC SCATTERING FACTORS AND THE DISTRIBUTION OF ELECTRONIC DENSITY IN GALLIUM ANTIMONIDE. N.N.Sirota and E.M.Gololobov.
Dokl. Akad. Nauk SSSR, Vol. 138, No. 1, 162-4 (May 1, 1961).
In Russian.

The first of a series of papers on the distribution of electron density in antimonides of the elements of the third group of the periodic system. An account is given of the investigation of GaSb by X-ray methods.
K.G.Ma

11561 X-RAY MEASUREMENT OF THE SCATTERING FACTOR OF IRON IN ORDERED Fe_3Al.
Y.Komura, Y.Tomiie and R.Nathans.
J. Phys. Soc. Japan, Vol. 15, No. 8, 1434-9 (Aug. 1, 1960).

X-ray measurements on the absolute integrated intensities of several superlattice reflections on an ordered Fe_3Al single crystal were made to obtain an estimate of the number of localized 3d electrons in iron. The experiments were made with Mo K_α radiation with a thin single crystal cut for transmission geometry so as to avoid surface roughness effects. Extinction effects, minimized by restricting the measurements to the comparatively weak superlattice reflections, were estimated from a wavelength analysis of the integrated intensities. Finally, neutron analysis was used for obtaining a knowledge of the state of atomic ordering in the particular sample and for establishing the temperature factors of the iron and aluminium atoms. Calculations of the iron scattering factor from the final results show it to be in substantial agreement with that of the free iron atom (6 3d electrons). This is in agreement with the conclusions of Batterman (Abstr. 5258 of 1959) and contrasts with the low number of 3d electrons given by Weiss and DeMarco (Abstr. 3583 of 1958).

11562 THE CALCULATION OF IONIC RADII FROM INTERIONIC DISTANCES. E.Kordes.
Naturwissenschaften (Germany), Vol. 47, No. 20, 463 (Oct., 1960).
In German.

An empirical relation is used to estimate radii for ions of alkali and alkaline earth metals, for halogens and for oxygen, sulphur, selenium and tellurium.
W.J.Orville-Tho

11563 CRYSTAL STRUCTURE AND GROWTH OF METALLIC OR METALLIC-OXIDE SMOKE PARTICLES PRODUCED BY ELECTRIC ARCS.
J.Harvey, H.I.Matthews and H.Wilman.
Disc. Faraday Soc. (GB), No. 30, 113-23 (1960).

Electron- and X-ray diffraction and electron microscopy are used to investigate the structure and form of smokes from d.c. arcs, in air at atmospheric pressure, between two electrodes of the same metal. With Ag and Au the smoke particles consist entirely of the metal, and the spherical particles from the Pb and Bi also contain metal, with an outer layer of oxide, however. The other smokes consist of oxide particles which are either globular or nearly so, for oxides having a high temperature of crystallization (Al, Ti, Zr and Ta); or polyhedral in those having a low temperature of crystallization (Cu, Zn, Cd, Sn, Fe, Co, Ni, W); or a mixture of these types (Mo and Sb). In both cases the particles tend markedly to adhere together in chains. A lower limit for the temperature of condensation of the oxide smokes is indicated from their crystalline nature and, for TiO_2 and Sb_2O_3, also from their particular crystal structure of the possible polymorphic types.

ct of pressure of the atmosphere (air) on the form of the aerosol nvestigated for Au and Ag evaporated from W wire, and also from and Ag wires respectively.

11564 STRUCTURE OF VAPOUR-DEPOSITED CARBON. G.Colligan and F.Galasso.
ure (GB), Vol. 190, 621-2 (May 13, 1961).

X-ray photographs are reproduced of pyrolitic carbon, deposited various temperatures, and are compared with the photograph for mal graphite. The comparison shows that high temperature in elf is not the controlling factor for producing an ordered struct-
R.F.S.Hearmon

11565 DIFFERENCE OF X-RAY REFLECTION INTENSITIES FROM OPPOSITE DIRECTIONS OF THE {111}-PLANES IN P. H.Pfister.
Naturforsch. (Germany), Vol. 16a, No. 4, 427-9 (April, 1961). German.

The ratios of reflection intensities from the 111 and $\bar{1}\bar{1}\bar{1}$ orders d from the 333 and $\bar{3}\bar{3}\bar{3}$ orders were measured, and found to agree ll with theoretical predictions. A.R.Stokes

11566 AN ELECTRON DIFFRACTION STUDY OF TUNGSTEN CARBIDE WC. L.N.Butorina.
ristallografiya (USSR), Vol. 5, No. 2, 233-7 (March-April, 1960). Russian.

The preparation of WC and W_2C films is described. From WC lms 46 reflections were measured and the structure determined means of $|F(hkl)|^2$ and F(hkl) Fourier sections. The cell is hexa-nal with a = 2.90, c = 2.831A; space group D^1_{3h}. The W atom is at 0, 0, 0) and the C atom at $(\frac{1}{3}, \frac{2}{3}, \frac{1}{2})$. The results would seem to nfirm the structure put forward by Westgren and Phragmen Zeitschrift für anorganische und allgemeine Chemie, Vol. 156, 7-36 (1926)]. [English translation in: Soviet Physics–Crystallo-raphy (USA), Vol. 5, No. 2, 216-20 (Sept.-Oct., 1960)].
J.Iball

11567 THE STRUCTURE ANALYSIS OF $AuCu_3$ BY MEANS OF A FOURIER TRANSFORMATION OF X-RAY DIFFUSE CATTERINGS. K.Doi.
. Phys. Soc. Japan, Vol. 15, No. 10, 1815-22 (Oct., 1960).

The method of analysing the two-dimensional disordered tructure using the function;

$$\varphi_H(x_1,x_2) = \iint A(s_1,s_2) \frac{\sin \pi a_1(s_1 - s_1^H)}{\pi(s_1 - s_1^H)} \times \frac{\sin \pi a_2(s_2 - s_2^H)}{\pi(s_2 - s_2^H)} \times \exp 2\pi i\{(s_1 - s_1^H.x_1) + s_2 - s^H.x_2)\}ds_1 ds_2$$

s described, where s_1^H and s_2^H are the coordinates of a relpoint I(= hk0), and $A(s_1, s_2)$ the amplitude of the diffuse scattering at the oint (s_1, s_2) in reciprocal space. The method is applied to the isordered structure of Cu_3Au projected upon (001), giving the tatistical parameters describing the atomic composition of each tomic site. The unit cell compositions, which are readily derived rom the atomic site compositions, are found appreciably deviated rom those corresponding to the bulk composition of Cu_3Au, the Au-rich cell being surrounded by the Cu-rich ones. This suggests hat the ordering of this alloy progresses rather by the inter-hanges of neighbouring atoms than by the growth of domains in which hich Au atoms are supposed not to come in contact with each other. In Appendices remarks are made in relation to the short-range order parameters, and the significances of phase assignments for diffuse scatterings are discussed.

CRYSTAL STRUCTURE OF CHROMIUM SULPHIDES.
See Abstr. 11250

11568 AN X-RAY STUDY ON THE STRUCTURE OF COBALT DICHLORIDE HEXAHYDRATE. J.Mizuno.
J. Phys. Soc. Japan, Vol. 15, No. 8, 1412-20 (Aug., 1960).

The crystal structure of $CoCl_2.6H_2O$ was determined by the X-ray single crystal method. The unit cell is monoclinic with a = 10.34 A, b =7.06 A, c = 6.67 A and $\beta = 122°20'$. The space group is C^3_{2h} – C2/m and the unit cell contains two molecules. Two Cl^- ions and four water molecules are octahedrally coordinated to a Co^{2+} ion to form the group $[CoCl_2.4H_2O]$. These groups are held together parallel to the b axis by O...H–O type hydrogen bonds. The other two water molecules of the formula unit are far from Co^{2+} ion. The crystal has a layer structure parallel to (001), and this causes a perfect cleavage. The structure proposed for this salt by Stroganov et al.(1958) seems to be incorrect.

11569 SOME STRUCTURAL DATA FOR CUBIC METABORIC ACID. J.L.Parsons, A.H.Silver and M.E.Milberg.
J. chem. Phys. (USA), Vol. 34, No. 6, 2192-3 (June, 1961).

Gives data from X-ray diffraction, infrared absorption and nuclear magnetic resonance absorption measurements; it appears that all the B atoms are tetrahedrally coordinated, and that there are rather short H bonds, with O–H–O distance 2.5 A.
J.Hawgood

11570 FALSE SYMMETRY OF LAWSONITE. I.M.Rumanova and N.V.Belov.
Kristallografiya (USSR), Vol. 5, No. 2, 215-17 (March-April, 1960). In Russian.

It is pointed out that the data published on lawsonite $CaAl_2[SiO_7](OH)_2$ does not support the suggestion of Pabst [Zeitschrift für Kristallographie (Germany), Vol. 112, 53 (1959)] that the structure displays false symmetry. It cannot therefore be an illustration of the Templeton effect (Abstr. 8473 of 1956). [English translation in: Soviet Physics–Crystallography (USA), Vol. 5, No. 2, 199-201 (Sept.-Oct., 1960)]. J.Iball

11571 OUTLINE OF A CRYSTAL STRUCTURE BY MORPHOLOGICAL ANALYSIS. J.D.H.Donnay and G.Donnay.
C.R. Acad. Sci. (France), Vol. 252, No. 13, 1982-3 (March 27, 1961). In French.

Positions of atoms in (Fe, Mn) (Nb, Ta)$_2O_6$ are indicated by morphology, and are compared with those given by Sturdivant (1930).
A.R.Stokes

11572 AN X-RAY STUDY OF THE $Pb_3NiNb_2O_9$ - $Pb_3MgNb_2O_9$ SYSTEM. I.G.Ismailzade.
Kristallografiya (USSR), Vol. 5, No. 2, 316-17 (March-April, 1960). In Russian.

X-ray powder patterns of $Pb_3MgNb_2O_9$ (I), of $Pb_3NiNb_2O_9$ (II) and of solid solutions of I and II were taken at 22°C and patterns of I were also obtained at -15°C. The parameter a varies at 22°C from 4.025A for pure II to 4.031A for a 50% solid solution and to 4.041A for pure I. At -15°C a for I is 4.020A. Superlattice lines were observed in all the specimens. The types of bonding in these structures are discussed. See also Abstr. 6376 of 1961. [English translation in: Soviet Physics–Crystallography (USA), Vol. 5, No. 2, 292-3 (Sept.-Oct., 1960)].

11573 STRUCTURE OF AND METAL–METAL BONDING IN $Rh(CO)_2Cl$. L.F.Dahl, C.Martell and D.L.Wampler.
J. Amer. Chem. Soc., Vol. 83, No. 7, 1761-2 (April 5, 1961).

Detailed X-ray investigation of $Rh(CO)_2Cl$ revealed a structure in which two essentially planar $Rh(CO)_2Cl$ groups intersect at an 127° angle, the resulting dimers being apparently linked by direct Rh–Rh bonds to form infinite chains, the Rh–Rh bond distance being 3.31A. The structural aspects in the solid and in solution are discussed, and the structure of $Co_2(CO)_8$ and $Co_2(CO)_6C_2H_2$ and other similar compounds with metal–metal bonding is inferred from that of $RH(CO)_2Cl$. L.Mordecai

11574 CRYSTAL STRUCTURE OF VANADYL BISACETYLACETONATE. GEOMETRY OF VANADIUM IN FIVE-FOLD COORDINATION. R.P.Dodge, D.H.Templeton and A.Zalkin.
J. chem. Phys. (USA), Vol. 35, No. 1, 55-67 (July, 1961).

The structure was determined from three-dimensional X-ray diffraction data. The crystals are triclinic, space group P$\bar{1}$, with a = 7.53 ± 0.02 A, b = 8.23 ± 0.03 A, c = 11.24 ± 0.04 A, $\alpha = 73.0°$, $\beta = 71.3°$, $\gamma = 66.6°$, Z = 2. The structure consists of discrete molecules of $VO(C_5H_7O_2)_2$. Each vanadium atom has five oxygen neighbours at the corner of a rectangular (nearly square) pyramid, with vanadium near its centre of gravity. The vanadium–oxygen distances are 1.56 A to the apex atom (vanadyl oxygen) and 1.96, 1.96, 1.97, and 1.98 A to the others. Other bond distances average 1.28 A for C–O, 1.40 for C–C (ring), and 1.52 A for C–C (methyl). Standard deviations are 0.01 A for V–O bonds and 0.02 A for C–O and C–C bonds. Each acetylacetone skeleton is planar, and this plane makes an angle of 163° with the plane of the other acetylacetone skeleton of the same molecule.

ALLOYS . METALLURGY

11575 THERMODYNAMIC THEORY OF RELAXATION PHENOMENA IN BINARY SOLID SOLUTIONS.
O.S.Zdorovets'.
Ukrayin. fiz. Zh. (USSR), Vol. 4, No. 2, 201-6 (1959). In Ukrainian.

The straining of a solid solution at a finite velocity leads to a non-equilibrium state, which is characterized by the strain tensor values, temperature, concentration and also by the internal parameter-relaxation tensor. When the system approaches the state of static equilibrium, the relaxation tensor tends to some equilibrium value which is the function of the strain, temperature and concentration. An expression is obtained for the free energy of the strained solid solution with finite velocity from which the values of the stress tensor and concentration change is determined for any amount of the isothermally strained solid solution. The stress and concentration change in the given solid solution sphere at a definite moment depends upon the value of the strain at that place and time and also upon the previous straining and the concentration change. The value of the elastic after-effect, which also depends — apart from the strain tensor — upon the straining rate, is determined as well.

11576 CHANGES OBSERVED IN THIN FILMS OF IRON-ALUMINIUM ALLOYS HEATED IN AIR OR A VACUUM.
P.Pepin, L.Tertian and J.J.Trillat.
C.R. Acad. Sci. (France), Vol. 252, No. 13, 1885-9 (March 27, 1961). In French.

Alloys containing 13.6% (corresponding to Fe_3Al), 20% and 30% (corresponding to FeAl) of aluminium were prepared by condensation on the face of a freshly cleaved crystal of sodium chloride either at room temperature or at 400°C. The metal film was held on a grid after the salt had been removed by distilled water. Electron diffraction patterns were made from the fresh films, after heating in vacuo and following oxidation in air at several temperatures up to 1000°C. At 900°C and above, the 13.6% and 20% Al alloy diagrams showed the oxides α-Fe_2O_3 and Fe_3O_4; below this temperature only the α-Fe_2O_3 was indicated. The 30% Al alloy gave a diagram of FeAl at 400°C and at 900°C a complex mixture of γ-aluminium and α-Al_2O_3. At 1000°C the alloy gave a different diagram with indications of the presence of spinel (FeO,Al_2O_3). The work is complementary to that of other authors using X-ray techniques. V.R.Switsur

11577 STUDY ON THE ORDERED ALLOYS OF GOLD—MANGANESE SYSTEM BY ELECTRON DIFFRACTION. II. Au_4Mn. D.Watanabe.
J. Phys. Soc. Japan, Vol. 15, No. 7, 1251-7 (July, 1960).

For Pt I, see Abstr. 9146 of 1961. The alloy was investigated by electron diffraction, using oriented, evaporated films. This ordered alloy was found below about 400°C to have the body-centred tetragonal unit cell which is 2.5 times as large as the fundamental cell in volume. The structure is isomorphous to that of Ni_4Mo and belongs to the space group $I4/m-C_{4h}^5$. This structure is not the so-called anti-phase domain structure. Some qualitative discussions are given of the structural transition between the ordered Au_4Mn and Au_3Mn and of the origin of ferromagnetism in Au_4Mn, on the basis of the proposed structure model.

11578 STUDY ON SOME Tl BASE ALLOYS, WITH REFERENCE TO THEIR ELECTRONIC STRUCTURE. R.Suganuma.
J. Phys. Soc. Japan, Vol. 15, No. 8, 1395-1409 (Aug., 1960).

Kinds of phases and phase boundaries were determined at room temperature for Tl-rich sides of the alloy systems of Tl—Cd, Tl—Sn and Tl—Sb by X-ray and electron diffraction. From the consideration of experimental results obtained in the present work as well as in previous works, it was deduced that phase boundaries of a particular structure in some Tl base alloys appeared to correspond to the same electron: atom ratio and to be affected mainly by the electronic factor. The results obtained from the lattice constant and density measurements in the f.c.c. region of Tl—Sn system, which was confirmed to be stable, were interpreted in terms of the Brillouin zone concept. Considering Matyas' result (1948) for trivalent Al, a suggestion for the high energy portion of the N(E) curve for the f.c.c. structure was proposed.

11579 STUDY ON THE ORDERED PHASES WITH LONG PERIOD IN THE GOLD-ZINC ALLOY SYSTEM. I. SURVEY OF CRYSTAL STRUCTURES AND CALORIMETRIC MEASUREMENT. H.Iwasaki, M.Hirabayashi, K.Fujiwara, D.Watanabe and S.Ogawa.
J. Phys. Soc. Japan, Vol. 15, No. 10, 1771-83 (Oct., 1960).

The structures of the ordered phases in the Au—Zn alloy syste were studied in detail by means of X-ray and electron diffraction on single crystal samples, and order—disorder and other kinds o phase transitions involved in the present system were also studie by the measurement of specific heat. The previously proposed structures of $Au_{3+}Zn$, $Au_3Zn[H]$, $Au_3Zn[R]$ were substantially con firmed and that of Au_3Zn_3 only partly. Moreover, details in these structures were revealed; in $Au_{3+}Zn$ some type of strong lattice modulation is present, and in $Au_3Zn[R]$ two types of structure, $Au_3Zn[R_1]$ and $Au_3Zn[R_2]$, certainly exist. The transition behavio of the alloys with changing temperature was investigated on samps of various compositions and the thermodynamic data are presente. The phase diagram of the Au-rich side of the present system is reasonably corrected by the present experiment. The orientation distribution of the ordered crystals formed in the originally disordered crystal and the nature of the transition, Au_3Zn [H] → Au_3 are briefly discussed.

11580 THE NATURE OF THE SHORT-RANGE ORDER OF ALLOYS OF THE Fe—Cr SYSTEM. P.O.Suprunenko
Ukrayin. fiz. Zh. (USSR), Vol. 3, No. 5, 673-7 (1958). In Ukrainia.

It is shown that a preliminary high-temperature annealing of alloys with a Cr content of 45, 47 and 49 at. %, respectively, raise the Curie temperature and specific conductivity throughout the temperature region. The results obtained are discussed, proceed from the assumption of the formation of a negative short-range or

11581 THE P—T DIAGRAM OF BISMUTH AT PRESSURES O UP TO 30 000 kg/cm². E.G.Ponyatovskii.
Kristallografiya (USSR), Vol. 5, No. 1, 154-6 (Jan.-Feb., 1960). In Russian.

The phase-diagram of Bi was determined by thermal analysis at pressures up to 30 000 kg/cm² and at temperatures between −1 and +300°C. Four modifications, $\alpha-\delta$, were observed, the $\alpha-\beta$ and $\beta-\gamma$ boundaries being established with some precision. The coordinates of the ternary point $\beta-\gamma-\delta$ were also determined, an an estimate made of the heat effect of the $\gamma-\delta$ transformation. [English translation in: Soviet Physics—Crystallography (USA), Vol. 5, No. 1, 147-9 (July-Aug., 1960)]. J.Thew

11582 SURFACE ENERGY EFFECT ON DIFFUSION-CONTROLLED PARTICLE GROWTH. G.A.Somorjai.
J. chem. Phys. (USA), Vol. 35, No. 2, 655-8 (Aug., 1961).

A theory of diffusion- and surface-energy-governed particle growth is presented for spherical precipitates in solids. The high surface energy of small particles retards the growth in the initial stage of the process. For large particles the limiting case is the diffusion-controlled growth as the surface-energy contribution becomes negligible.

11583 SEGREGATION AND SOLUBILITY OF IRON AND TIN IMPURITIES IN GERMANIUM ON CRYSTALLIZATION
V.N.Vasylevs'ka and E.G.Mỹselyuk.
Ukrayin. fiz. Zh. (USSR), Vol. 3, No. 1, 71-8 (1958). In Ukrainian

An investigation was made of the incorporation of iron and tin in single-crystal germanium during pulling from the melt. The segregation coefficients of Fe and Sn were obtained by measuring the amount of impurity in the crystal (C_S) and the amount of impurity in the melt at the moment of introducing a portion of the C_S impurity into the crystal (C_L). The respective values obtained we $k_0 = 1.0 \times 10^{-5}$ and $k_0 = 1.5 \times 10^{-2}$. The effective segregation coefficients of iron and tin, beginning with C_S values of ~ 2.5×10 and 2×10^{18} l/cm³, respectively, and higher, rise sharply. This ca be explained – with the data obtained from autoradiographs and micrographs of the crystal structure – by the accumulation of impurities (along the boundaries and within the mosaic blocks) in quantities exceeding their solubility limits. This furnishes ground for the assumption that the C_S values given above correspond to the solubility limits of iron and tin in germanium during crystallization, which for the iron impurity agrees with the data of Bugai at al.(Abstr. 9426 of 1957).

11584 THE DETERMINATION OF METAL RECRYSTALLIZATION TEMPERATURES. L.N.Larikov.
Ukrayin. fiz. Zh. (USSR), Vol. 3, No. 5, 664-7 (1958). In Ukrainian with summary (1 p.) in Russian.

On the basis of previously published formulae, the author

mates the times of formation of the first nuclei with an istorted lattice τ_N and the times of their growth to visible ensions ($L \cong 10^{-4}$ cm) at various reduced temperatures. It is wn that with a practically applicable annealing time (from 1 sec 1000 hr) and high degress of deformation ($\epsilon > 40\%$), the time of earance of the first visible recrystallized areas τ is determined efly by the linear rate of growth of the centres G. In this case, in nplete accordance with Bochwar's rule, the appearance of a ible recrystallized grain during the time $\tau = \frac{1}{2}$-1 hr requires a nperature of not less than $0.3T_m$.

11585 THE MOBILITY OF ATOMS IN METALS IN THE REGION OF RECRYSTALLIZATION TEMPERATURES.
N.Larikov.
rayin. fiz. Zh. (USSR), Vol. 3, No. 5, 668-72 (1958). In Ukrainian.

On the basis of the thermodynamic theory of diffusion, the pendence of the linear rate of growth G of the recrystallization ntres on the effective atomic self-diffusion coefficient D* is termined for greatly deformed regions of metals

$$G = \frac{D^*}{kT}\frac{\Delta\mu}{\Delta x}\frac{a}{h} = -.\Delta\mu.\exp(\Delta S/R).\exp(-Q/TR)\frac{a}{\Delta x},$$

ere $\Delta\mu/\Delta x$ is the gradient of chemical potential between the ntre of recrystallization and the surrounding deformed matrix, a the shortest distance between atoms. It is shown that to form at e recrystallization temperature a centre of magnitude $L \cong 10^{-4}$ cm aring the time of annealing $\tau = 1$ hr, a linear rate of growth $= L/2\tau \geq 10^{-8}$ cm/sec is necessary. Taking $\Delta\mu \leq 100$ cal/(g atom) nd $\Delta x \geq 10^{-8}$ cm, it is possible to calculate the minimum value of D* the region of the recrystallization temperatures $T_R = 0.3 - 0.4\,T_m$. comparison of D* with the coefficient of the volume D and boundary g self-diffusion of certain metals at the respective temperatures hows that the atomic diffusion mobility on recrystallization of etals is approximately the same as with boundary diffusion. In e case of pure metals $a/\Delta x \cong 1$ practically, since the centre will vidently grow continuously owing to the atoms in direct contact ith its surface. In the case of alloys, the appearance at the boundary f a growing centre of an interlayer enriched by the alloyed element eads to a change in $\Delta\mu$, an increase in Δx, and a decrease in the ate of migration of the basic metal atoms due to partial screening f the centre surface.

11586 Fe^{57} MÖSSBAUER EFFECT IN Cu–Ni ALLOYS.
G.K.Wertheim and J.H.Wernick.
Phys. Rev. (USA), Vol. 123, No. 3, 755-7 (Aug. 1, 1961).

The Mössbauer effect of Fe^{57} was used to study the properties of iron impurity in the complete range of composition of Cu–Ni alloys. The isomer shift indicates a small decrease in the total electronic density at the Fe^{57} nucleus in going from pure Ni to pure Cu. The magnetic field at the iron nucleus at 0°K decreases by 9% in the range from 0 to 40% Cu. Both results show that only minor changes take place in the atomic configuration of the iron. The linewidth, measured in the paramagnetic alloys, is smallest in pure copper and largest near the middle of the composition range. The rapid change in linewidth with small nickel admixture can result from quadrupole splitting due to the field gradients arising from the spatial charge fluctuations around an impurity atom. Some of the broadening can also arise from an inhomogeneous isomer shift due to a range of surroundings of an iron atom in the alloy.

OTHER SOLID FORMS

11587 SUMMARIZED PROCEEDINGS OF A CONFERENCE ON PHYSICS OF POLYMERS — BRISTOL, JANUARY 1961.
Brit. J. appl. Phys., Vol. 12, No. 6, 261-7 (June, 1961).

The conference arranged by The Institute of Physics and The Physical Society was held at the University of Bristol on January 10-12, 1961. The papers presented in the five sessions, devoted to Chain Statistics and Solution Properties, Molecular Motions, Crystallinity (two) and Irradiation Effects, together with an Evening Lecture by Sir Gordon Sutherland, F.R.S., are summarized.

PROPERTIES OF POLYVINYLIDENE FLUORIDE.
See Abstr. 11333

11588 GASEOUS DIFFUSION IN POROUS MEDIA. III. WET GRANULAR MATERIALS. J.A.Currie.
Brit. J. appl. Phys., Vol. 12, No. 6, 275-81 (June, 1961).

For Pt II see Abstr. 14693 of 1960. The diffusion of hydrogen through granular materials partly saturated with water was measured by a non-steady state technique previously described. The two types of sample used consisted of solid particles (unimodal pore-size distribution) and porous particles (bimodal pore-size distribution), and all measurements were made on samples being dried from saturation. Coefficients of diffusion D were calculated, and for the range over which the larger pores were emptying the empirical equation $D = D_V(\epsilon/\epsilon_v)^\sigma$ fitted all materials, where ϵ is the fractional air-filled volume, ϵ_v is the volume occupied by the larger-pore phase, and where D_V is the diffusion coefficient when only this phase is air-filled. For all materials $\sigma \cong 4$ whether the samples were uniform or of mixed sizes. No such relationship existed over the subsequent range in which the smaller pores were drained. Over this range D must be a function of at least five independent variables — the total porosity ϵ_c, the shape factor for the crumbs or inter-crumb pores k, the shape factor for the particles forming the crumbs or crumb pores k_c, and the moisture content of the sample. The spatial distribution of pores within a porous medium can be as important as the sizes of the pores. The factors k and m, previously introduced as particle-shape factors now have a greater significance as measures of the geometrical complexity of a porous system. Adding water can either increase or decrease the complexity, depending on the amount added and the nature of the system. The agricultural significance of diffusion between the crumbs D_V and within the crumbs D_C is discussed, and it is suggested that D_C, or its associated complexity factor k_C, might be used as an index of soil structure.

11589 GLASS TRANSITION PHENOMENA AND RHEOLOGICAL PROPERTIES OF PETROLEUM ASPHALT.
Y.Wada and H.Hirose.
J. Phys. Soc. Japan, Vol. 15, No. 10, 1885-94 (Oct., 1960).

Volume dilatometry was carried out on nine kinds of asphalt with a wide range of asphaltene content X. The glass transition temperature T_g became higher with increase of X. The discontinuity in thermal expansion coefficient at T_g decreased with X, and T_g could no longer be observed for $X > 70\%$. The complex shear modulus and shear creep compliance of five samples of asphalt were measured. Above T_g, the asphalt was viscoelastic. The temperature–time reducibility applies to asphalt. The temperature dependence of retardation times and steady flow viscosity obeys Williams–Landel–Ferry's equation, the standard temperature involved in this equation being 56° higher than T_g for all the samples. The distribution function of retardation times is approximately wedge shaped when plotted in logarithmic scales, the slope being 0.5 or less according to X. The steady flow viscosity and the maximum retardation time reduced to 20°C markedly increase with X. These facts allow some predictions about molecular behaviour in asphalt to be made.

Surfaces . Films . Adsorption

11590 STUDY OF ELECTRON BOMBARDMENT OF THIN FILMS. G.B.Gilbert, T.O.Poehler and C.F.Miller.
J. appl. Phys. (USA), Vol. 32, No. 8, 1597-1600 (Aug., 1961).

An experimental study was made of methods by which the physical properties of thin metallic films may be changed. In particular, emphasis has been placed on investigating alterations of the crystal structure of certain films subjected to electron bombardment. The films, after being vapour-deposited on amorphous substrates, were bombarded by a 35 keV electron beam in a zone recrystallization process. X-ray diffraction photographs and photomicrographs indicate substantial crystal growth in films of indium, bismuth, and germanium.

11591 INTERFERENCE METHOD FOR MEASURING THE THICKNESS OF EPITAXIALLY GROWN FILMS.
W.G.Spitzer and M.Tanenbaum.
J. appl. Phys. (USA), Vol. 32, No. 4, 744-5 (April, 1961).

Since the dielectric constant of semiconductors is dependent on the carrier concentration, radiation can be reflected from the boundary between a heavily doped semiconductor and a lightly doped layer deposited on it by an epitaxial process. Interference effects will occur between the radiation reflected at the boundary and that reflected from the surface of the epitaxial layer, and the thickness of the layer can be deduced from the reflection spectrum. Results are given for layers of germanium and silicon.

C.Hilsum

GERMANIUM FILMS ON GERMANIUM OBTAINED BY THERMAL EVAPORATION IN VACUUM. See Abstr. 11297

11592 SINGLE-CRYSTAL TIN FILMS. R.W.Vook.
J. appl. Phys. (USA), Vol. 32, No. 8, 1557-61 (Aug., 1961).

High-purity tin films were made in ultrahigh vacuum by evaporation on (001) faces of NaCl at liquid nitrogen temperature and 0°C. An evaporation rate of approximately 50 A/sec was used. Film thicknesses ranged from 1000 to 3600 A. The films were allowed to warm to room temperature before they were removed from the vacuum system and examined by the techniques of electron diffraction and electron microscopy. Single-crystal films were obtained when the substrates were at liquid nitrogen temperature and when cleaved surfaces and short successive evaporation times were used. If the substrates were at 0°C, or one continuous evaporation of more than about 10 sec was made, the resulting film was polycrystalline and (100) oriented. Grain growth in all the polycrystalline films could be produced by electron-beam bombardment in the electron microscope. Some of the factors influencing grain growth are discussed.

11593 DISTRIBUTION OF SPACE CHARGE IN HOMOGENEOUS METAL OXIDE FILMS. J.N.Butler.
J. chem. Phys. (USA), Vol. 35, No. 2, 636-43 (Aug., 1961).

Poisson's equation is solved exactly for a homogeneous semiconducting oxide film on a metal or semiconductor substrate. The potential drop from the interior of the substrate to the external surface of the oxide is given as a function of the thickness of the oxide, and the distribution of potential within the layer is given. The form of the functions is shown for an arbitrary choice of constants and the potential drop across the oxide film as a function of thickness is calculated for Cu_2O on Cu at 1000° C.

11594 ELECTRON DIFFRACTION STUDY OF THE STRUCTURE OF THIN FILMS OF SOME COMPOUNDS OF TYPE $A^{III} B^{V}$ AND THEIR ALLOYS. S.A.Semiletov and L.I.Man.
Kristallografiya (USSR), Vol. 5, No. 2, 314-15 (March-April, 1960). In Russian.

An electron diffraction study was made on thin films of Ga and In arsenides and antimonides, and on their alloys. Specimens were prepared on NaCl crystals or on celluloid films by sublimation, followed by annealing in vacuo at 300°-400°C; during sublimation the compounds partly dissociated giving films rich in one of the elements. Before annealing, films of GaAs and InAs were always amorphous, but not those of GaSb or InSb. The electron diffraction pattern of GaAs was indexed, giving a F.C.C. cell of parameter a = 5.64 ± 0.02A. Films of GaSb and InAs gave lines due to a hexagonal phase as well as those of the cubic phase. The system InAs—GaAs was found to give a continuous range of solid solutions, whose parameters ranged from 5.64A for GaAs to 6.05A for InAs. Similarly in the system InSb—GaSb a ranged continuously from 6.10A to 6.46A. The system InSb—InAs gave limited solid solutions, which became continuous on annealing for up to 3 hours. [English translation in: Soviet Physics – Crystallography (USA), Vol. 5, No. 2, 289-91 (Sept.-Oct., 1960)]. R.V.Coates

11595 AN ELECTRON-DIFFRACTION STUDY OF THE STRUCTURE OF THIN LAYERS OF AMORPHOUS SELENIUM. A.I.Andrievskii, L.D.Nabitovich and Ya.V.Voloshchuk.
Kristallografiya (USSR), Vol. 5, No. 3, 369-74 (May-June, 1960). In Russian.

Films of amorphous selenium about 1000 A thick were prepared by vacuum evaporation of the selenium on to collodion films maintained at 20°C. The substrates were dissolved away and the selenium films supported on tantalum diaphragms. The films were examined by electron-diffraction before and after being given various heat treatments. From the electron scattering curves the radial distribution curves were drawn, and hence the radii of the coordination spheres and coordination numbers determined. Results are compared in a table with those obtained from X-ray diffraction studies. Two amorphous states were found to exist with the largest possible coordination number, one at 20°C, the other at 70°C. In between a gradual transition occurs, without any crystallization. [English translation in: Soviet Physics—Crystallography (USA), Vol. 5, No. 3, 349-54 (Nov.-Dec., 1960)]. R.V.Coates

11596 DEPOSITION OF METALLIC FILMS BY ELECTRON IMPACT DECOMPOSITION OF ORGANOMETALLIC VAPORS. A.G.Baker and W.C.Morris.
Rev. sci. Instrum. (USA), Vol. 32, No. 4, 458 (April, 1961).

Thin films of tin and lead were produced on glass and metal substrates by electron beam decomposition of tetrabutyl tin tetramethyl tin, and tetraethyl lead. The beam of electrons is aimed at the substrate through the vapour at a pressure of 0.5μ Hg. Two distinct methods are used, one in which there is an excess o electrons over the number of molecules, arriving at the substrat vice versa. With the former method, the films are not affected b the non-uniformity of the electron beam. T.C.T

USE OF MONOMOLECULAR LAYERS IN EVAPORATED-FI TUNNELLING DEVICES. See Abstr. 11320

11597 OXYGEN ADSORPTION ON SILICON AND GERMANI H.D.Hagstrum.
J. appl. Phys. (USA), Vol. 32, No. 6, 1020-2 (June, 1961).

Data are presented which yield relative magnitudes of the initial, room-temperature sticking probabilities S_0 of nitrogen o clean tungsten and oxygen on clean silicon and germanium. Taki S_0 to be 0.35 for N_2 on W, values of 1×10^{-2} and 8×10^{-4} are obtained for S_0 of O_2 on Si and Ge, respectively. Data are also given concerning the temperatures at which the automatically cl surface is thermally regenerated from the oxygenated surface fo both Si and Ge. See also Abstr. 10737.

11598 INTERPRETATION OF LOW-ENERGY ELECTRON DIFFRACTION PATTERNS OF ADSORBED GASES. E.Bauer.
Phys. Rev. (USA), Vol. 123, No. 4, 1206-8 (Aug. 15, 1961).

Recent observations of the adsorption of oxygen on nickel ar interpreted in terms of double-scattering processes instead of t single-scattering mechanism which has been used in all previou interpretations. This permits a simple explanation of the obser variation of the intensity of the diffraction pattern with electron energy and provides a plausible understanding of the early stage of adsorption.

11599 ELECTRONIC EXCHANGE BETWEEN HYDROGEN AND EVAPORATED NICKEL FILMS. Y.Mizushima.
J. Phys. Soc. Japan, Vol. 15, No. 9, 1614-31 (Sept., 1960). In Ger

The absorption of hydrogen on nickel film which was evapora under an ultra-high vacuum condition was measured. The relati between the absorption and the change of electrical resistance of film was closely studied, and apparently-complicated results wer found, which were very different from those of the previous reports. The effect of film thickness, measuring temperature, a annealing temperature were separately examined. Adsorption kinetics were also studied. From the experimental facts it was concluded that the adsorbed species were: (1) the negatively charged atom, (2) the positively charged atom and (3) the molecu The charge is however, relatively small. An explanation for the resistance change is suggested.

EFFECT OF CHEMISORBED HYDROGEN ON THE MAGNE-TIZATION OF NICKEL. See Abstr. 11432

11600 INTERACTION OF HYDROGEN AND OF NITROGEN WITH A MOLYBDENUM RIBBON.
R.A.Pasternak and H.U.D.Wiesendanger.
J. chem. Phys. (USA), Vol. 34, No. 6, 2062-8 (June, 1961).

Adsorption and desorption studies — by flash-filament and gauge techniques — gave information on surface coverages, stic probabilities, atom formation, and surface mobilities for the int action of gases with a molybdenum ribbon. For hydrogen, satura surface coverages were independent of pressure (10^{-8}-10^{-5} mm within experimental errors, but depended strongly on temperatu (225°-500°K). Adsorption below 320°K proceeded in two steps. layers were sucessively adsorbed and completed at 320° and 225 respectively; each contained close to two hydrogen atoms per su molybdenum atom. The sticking probability was 0.35; it remain constant during the formation of the first layer. At about 700°K, measurable amounts of hydrogen were retained on the ribbon su but the kinetics of atom formation above 1200°K suggested that traces of hydrogen might be adsorbed at much higher temperatu Finally, adsorbed hydrogen was readily replaced by other gases, such as nitrogen, even at room temperature. For the adsorption nitrogen, the saturation surface coverage decreased only about 3 from 225°-710°K; its value at room temperature was about one nitrogen atom per surface molybdenum atom. The initial stickin probability, in the same temperature range, decreased from 0.7 0.2.

11601 INFRARED SPECTRA OF ACETYLENE AND ACETYLENE DERIVATIVES ADSORBED ON ALUM AND SILICA. D.J.C.Yates and P.J.Lucchesi.
J. chem. Phys. (USA), Vol. 35, No. 1, 243-55 (July, 1961).

An infrared study of adsorbed acetylenes revealed several features of the nature and orientation of the adsorbed species.

lene, deuteroacetylene, methyl acetylene, and dimethyl lene are strongly chemisorbed at room temperature on alu- . Weak chemisorption also occurs with acetylene, deutero- lene, and methyl acetylene. The strongly held acetylene is normal to the surface, while the weakly held acetylene is llel to the surface. Similar effects occur with methyl acetylene, f the strongly held molecules being attached to the surface by cetylenic end. Both the strongly and weakly adsorbed thyl acetylene is adsorbed parallel to the surface. The sites onsible for the strong chemisorption of dimethyl acetylene are rent from those active in the strong chemisorption of acetylene. silica, no strong chemisorption occurred at room temperature ither acetylene or dimethyl acetylene. For both adsorbents, nteraction between the OD (and OH) groups of the surface and dsorbates was studied. Exchange takes place between the est frequency OH groups on alumina and the strongly adsorbed . An OD group at the expected frequency was observed r the exchange had taken place. The remaining two types of OH ips on alumina did not appear to interact with the strongly held cies, but only with the weakly held species. With dimethyl tylene, the silica OD groups interacted to much the same degree lid the two lower frequency alumina OD groups.

11602 A STUDY OF SORBED WATER ON CELLULOSE BY PULSED NMR TECHNIQUE.

asaki, T.Kawai, A.Hirai, T.Hashi and A.Odajima.
hys. Soc. Japan, Vol. 15, No. 9, 1652-7 (Sept., 1960).

The state of sorbed water on cellulose was studied by pulsed R technique. From the experimental results of spin—lattice xation time (T_1) and spin—spin relaxation time (T_2), observed a spin echo decay time, the following conclusions are derived. Two phases of the sorbed water are classified; the localized the mobile. (2) The correlation time (τ_N) derived from T_1 ng BPP theory (Abstr. 2529 of 1948), is consistent with that) derived from dielectric measurements. (3) T_1 is by one or two lers longer than T_2 in contradiction to BPP theory for extreme rowing case. As an explanation for this fact, it is proposed t when T_2 is considered, the effects of magnetic nuclei contained the absorbent must be taken into account, though no theory is en. (4) The average life-time of water molecule sorbed on lhlose in the localized state is estimated to be several hundredths a second and to decrease with temperature.

MICROSTRUCTURE EXAMINATION

(By X-rays and Electron and Other Microscopes)

11603 INTENSITY DISTRIBUTION ALONG A SPECTRAL LINE WIDTH VERSUS THE SIZE AND FORM OF A REFLECTING SURFACE. A.Z.Zhmuds'kyi

Ukrayin. fiz. Zh. (USSR), Vol. 3, No. 1, 116-23 (1958). In Ukrainian.

An analytical calculation of the line intensity distribution is given for X-ray reflection from a long narrow specimen. This distribution shows a pronounced irregularity — the line itself and a strongly diffuse tail. The line intensity maximum does not shift from its position with beam broadening and with change in the surface form of the reflecting specimen. High-dispersion X-radiography of large cylindrical specimens with diameters ranging from 5 to 100 mm was carried out. The lattice constant (within the limits of experimental error) does not depend upon the diameter of the specimen.

11604 THE SIMULTANEOUS PRODUCTION OF X-RAY INTERFERENCE AND X-RAY SHADOW PICTURES OF CRYSTALS. O.Brümmer.

Z. Naturforsch. (Germany), Vol. 15a, No. 10, 875-9 (Oct., 1960). In German.

An experimental set-up using a fine-focus X-ray tube is described in fair detail. Possible applications to studies of dislocations, etc., are suggested. A.R.Stokes

11605 LOW-ANGLE X-RAY DIFFRACTION OF CRYSTALLINE NONORIENTED POLYETHYLENE AND ITS RELATION TO CRYSTALLIZATION MECHANISMS.

L.Mandelkern, A.S.Posner, A.F.Diorio and D.E.Roberts.
J. appl. Phys. (USA), Vol. 32, No. 8, 1509-17 (Aug., 1961).

X-ray diffraction maxima at low angles were observed in crystalline but nonoriented linear polyethylene, the crystallization process being conducted from the melt of the pure undiluted polymer. Several orders of diffraction are observed in favourable cases, and the spacings corresponding to the first-order reflections range from 150-850 A. The values of the maxima depend on the mode of crystallization. Previous assertions that in such systems the maxima are limited to 100-200 A are shown to be very restrictive and typical only of crystallization processes conducted at very large undercooling. Major attention is focused on the properties of specimens crystallized isothermally at relatively low values of the undercooling. The spacings are very sensitive to the crystallization temperature in this range. The highest values are observed at low undercooling, and substantial decreases occur as the temperature is lowered. Concomitantly, the density observed after isothermal crystallization significantly decreases with a lowering of the crystallization temperature. The fact that a periodicity can be developed in such systems, the magnitude of the maxima, and their dependence on the crystallization temperature, is explicable by the application of nucleation theory. It is assumed that subsequent to the formation of critical-size nuclei from a bundle of polymer chains, crystal growth along the chain direction is severely retarded, while in the transverse direction essentially unimpeded crystallization occurs. From the observed temperature coefficient of the low-angle spacings, the ratio of the excess free energy (resulting from the junction of crystalline and amorphous regions at the crystallite ends) to the bulk enthalpy of fusion is found to be 2.6. The magnitude of this ratio receives confirmation from another type of experiment.

11606 MEASUREMENT OF THE INTENSITY IN ELECTRON DIFFRACTION BY A CdS SINGLE CRYSTAL.

S.Takagi and F.Fujimoto.
J. Phys. Soc. Japan, Vol. 15, No. 9, 1607-14 (Sept., 1960).

A method of measuring the intensity of electrons in electron diffraction patterns by the electron-bombardment-induced-current (EBIC) in a CdS single crystal is described. The CdS detector is moved in the diffraction camera by a screw which is driven by a synchronous motor. EBIC is measured directly by a automatic recording millivoltmeter. EBIC properties of good crystals selected from those prepared by Frerichs' method are given. It is shown that the intensity can be measured within 2-3% error, if suitable precautions are taken. An example of the measurement on TlCl is given.

11607 OBTAINING A REPLICA FROM A TRANSVERSE SECTION OF A THIN FILM.

R.Ya.Berlaga and M.I.Rudenok.
Fiz. tverdogo Tela (USSR), Vol. 3, No. 2, 625-6 (Feb., 1961). In Russian.

For abstract, see Abstr. 10284 of 1961. [English translation in: Soviet Physics—Solid State (USA), Vol. 3, No. 2, 458-9 (1961)].

PHYSICAL CHEMISTRY

11608 REVISION OF THE CLASSICAL LAW OF MOLAR BOILING POINT ELEVATION.
G.Kollár and J.Proszt.
Z. phys. Chem. (Germany), Vol. 215, No. 3-4, 215-28 (1960).
In German.

For non-polar solvents the relationship $\log \Delta T_p = x \log T + \log y_p$ holds, where x is a constant which is characteristic for this class of liquids and y_p is a function of the pressure. Both x and y can be determined experimentally. For a calculation of ΔT_p the boiling point must be known as a function of the pressure, i.e., the vapour pressure curve of the solvent. R.Schnurmann

THERMOCHEMISTRY . REACTIONS

11609 THERMODYNAMICS OF BINARY ION-EXCHANGE SYSTEMS. D.H.Freeman.
J. chem. Phys. (USA), Vol. 35, No. 1, 189-91 (July, 1961).

From an algebraic expression for the total excess free energy of a two-component ion-exchange system, separate expression are derived for the dependence of the logarithm of the activity coefficients of the two components upon the equivalent fraction of counterion in the exchanger. The numerical coefficients required by these expressions and the thermodynamic constant for the ion-exchange reaction are obtained from equilibrium measurements of species activities in the aqueous phase at varying exchanger compositions. This is illustrated with measurements on the distribution of chloride and perchlorate with anion-exchange resin.

11610 EQUILIBRIUM CONSTANT FOR ISOTOPE EXCHANGE IN AMMONIA FROM INFRARED SPECTRA. L.H.Jones.
J. chem. Phys., Vol. 33, No. 5, 1585-6 (Nov., 1960).

An explanation is given for the disagreement of values of equilibrium constants determined from infrared spectra with those obtained from statistical calculations and from mass-spectrometer measurements. Use of apparent absorption coefficients for the pure species at the same total pressure as in the exchange experiment leads to improved agreement. R.C.Seymour

11611 SEPARATION OF BORON ISOTOPES. V. THE PHENOL–BF_3 SYSTEM.
A.A.Palko, J.S.Drury and W.E.Bull.
J. chem. Phys. (USA), Vol. 35, No. 1, 103-5 (July, 1961).

For Pt IV, see Abstr. 17676 of 1960. The exchange of boron between BF_3 (g) and BF_3·phenol (1) was studied. The single-stage isotopic fractionation factor varied according to the equation $\log\alpha = (10.315/T) - 0.02423$, over the temperature range -8°C to 37°C. B^{10} is concentrated in the liquid phase. Vapour-pressure measurements of dilute and concentrated solutions of BF_3 in phenol were made at various temperatures from -10°C to 40°C. The freezing point of the BF_3·phenol complex was approximately -15°C; that for the BF_2·phenol, -5°C.

11612 SURFACE KINETICS AND PHYSICS INVESTIGATION OF THE REACTION BETWEEN SINGLE-CRYSTAL GERMANIUM AND IODINE. W.J.Heinecke and S.Ing, Jr.
J. appl. Phys. (USA), Vol. 32, No. 8, 1498-1504 (Aug., 1961).

A study of the kinetics of the reaction between iodine and single-crystal germanium and the resulting electrical surface was undertaken. An activation energy of 18.5 kcal/mol was found for the reaction of each of the three crystallographic planes studies. However, frequency factors were found to differ with orientation. An ageing effect of the surface was found through field-effect surface acceptor-like trap having an energy level $(E_t - E_v)$ of 0.44 eV was found and investigated. The density of the trap was found to be 1.4×10^{12} cm^{-2}.

11613 KINETIC MODEL FOR SOLID-STATE REACTIONS. R.E.Carter.
J. chem. Phys. (USA), Vol. 34, No. 6, 2010-15 (June, 1961).

A model for solid–solid or solid–gas reactions between spherical particles and a fine powder or gas is developed. The oxidation of uniformly sized nickel spheres is shown to fit this model to 100% reaction. Previously reported models are inadequate because they do not meet the boundary conditions set dow and because the volume of the product was assumed to equal th the reactants. The inadequacy of earlier experimental results explained by the failure to experimentally meet the boundary conditions imposed.

11614 DEVIATIONS FROM THERMAL EQUILIBRIUM AM REACTANT MOLECULES. B.Widom.
J. chem. Phys. (USA), Vol. 34, No. 6, 2050-6 (June, 1961).

A model of a chemically reacting system is considered in the reactant molecules are dilutely dispersed in an inert gas ar reaction is the result of binary collisions between inert and rea species. It is noted that during reaction the distribution of rea over their internal states is not that characteristic of equilibri It is shown that if κ is the rate constant of the reaction and κ_{eq} rate constant that would have characterized the reaction had th reactants been in equilibrium, then $\kappa = \kappa_{eq} - \bar{\tau}(\langle q^2\rangle - \langle q\rangle^2)$, w τ is a mean relaxation time, q is the reaction probability per u time from a particular reactant state, and $\langle\ \rangle$ is an average ov reactant states with an equilibrium distribution. The rate cons κ_{eq} is itself $\langle q\rangle$. A number of illustrations are given, and it i concluded that in real chemical systems $\langle q^2\rangle$ is probably of the order of magnitude of $\langle q\rangle^{1+\gamma}$ with $0 < \gamma < 1$. This has as a c sequence that κ is of the form $(1 - B\kappa_{eq}^{\gamma})\kappa_{eq}$. The quantity in parenthese describes the effect on κ of deviations from equilib and it is a decreasing function of temperature. It is suggested this might possibly be the explanation of the observed temperat decreasing pre-exponential factor in the rate constant for disso of diatomic molecules.

11615 DIFFUSION AND HETEROGENEOUS REACTION. IV. EFFECTS OF GAS-PHASE REACTION AND CONVECTIVE FLOW. H.Wise and C.M.Ablow.
J. chem. Phys. (USA), Vol. 35, No. 1, 10-18 (July, 1961).

For Pt III, see Abstr. 16370 of 1960. The kinetics of atom recombination by homogeneous and heterogeneous reaction are examined. The analysis includes the combined effects of first-order surface reaction and third-order gas-phase reaction in a system undergoing diffusive and convective flow. On the basis model the rate constants for the homogeneous rate of recombin of oxygen atoms and of hydrogen atoms are derived from publis experimental measurements.

11616 SOME DEDUCTIONS FROM A FORMAL STATISTIC MECHANICAL THEORY OF CHEMICAL KINETICS J.Ross and P.Mazur.
J. chem. Phys. (USA), Vol. 35, No. 1, 19-28 (July, 1961).

A perturbation solution of an assumed Boltzmann-type equ for bimolecular chemical reactions in a homogeneous gas phas consisting of molecules with or without internal degrees of free leads to the conclusion that the law of mass action as well as t usually assumed phenomenological rate expressions for chemic reactions, is strictly valid only in lowest order of the perturba Higher order perturbations introduce an affinity and time depe in the rate coefficient and the law of mass action becomes inad to the extent of the contribution of the effects of the perturbatio A transition state formulation of rate coefficients for bimolecu gas-phase reactions is presented under less restrictive suffici conditions than reported previously.

STUDY OF REACTION KINETICS BY ABSORPTION SPEC METRY. See Abstr. 10586

11617 SHOCK WAVE STUDIES BY MASS SPECTROMETR I. THERMAL DECOMPOSITION OF NITROUS OXI J.N.Bradley and G.B.Kistiakowsky.
J. chem. Phys. (USA), Vol. 35, No. 1, 256-63 (July, 1961).

An apparatus is described in which the reacting gas behin reflected shock wave is sampled continuously and analysed at intervals of 50 or 100 μsec by a time-of-flight mass spectrom The thermal decomposition of N_2O in the temperature range 1780-2000°K was used as a test case to demonstrate that the experimental technique is valid. It has also been shown that t mechanism and rate constants of this reaction at high tempera are consistent with earlier measurements at much lower temp ture.

SHOCK WAVE STUDIES BY MASS SPECTROMETRY. II. POLYMERIZATION AND OXIDATION OF
618 YLENE. J.N.Bradley and G.B.Kistiakowsky.
em. Phys. (USA), Vol. 35, No. 1, 264-70 (July, 1961).
The polymerization and oxidation of acetylene were investi-
at temperatures from 1800°-2700°K and 950°-1100°K, respect-
, by the technique of time-of-flight mass spectrometry in
cted shock waves. In the absence of oxygen, a simple bimole-
reaction produces a dimer, probably vinylacetylene, and
r polymers, which appear to reach "equilibrium" with the
lene. A sharp drop in the concentration of these polymers is
rved at a later time, which is correlated with the formation
rbon after an induction period. In the presence of oxygen, a
r, probably diacetylene, is formed simultaneously with the
ation of CO and H_2O, after an induction period. This suggests
it is a product of the branching chain reaction, a specific
anism for which is proposed.

PROPAGATION OF A ⇌ B → C FLAMES.
1619 C.F.Curtiss, J.O.Hirschfelder and M.H.Taylor.
. of Fluids (USA), Vol. 4, No. 6, 771-7 (June, 1961).
The equations describing a flame supported by the chemical
tion A ⇌ B → C are solved by an iterative procedure using the
enius temperature dependence of the reaction rate constants.
found that an excellent approximation to a solution is obtained
etting the net rate of production of B to zero. This approxi-
ion is a form of the pseudostationary state approximation
ough B is not necessarily in near equilibrium with the reactant
In addition, explicit solutions are obtained for the temperature
concentration profiles using the ignition temperature approxi-
ion for the temperature dependence of the reaction rate
stants.

GROWTH OF EXPLOSION IN ELECTRICALLY
1620 INITIATED R.D.X.
Muller, D.B.Moore and D.Bernstein
ppl. Phys. (USA), Vol. 32, No. 6, 1065-75 (June, 1961).
The growth of explosion was studied both in powdered RDX,
ated by a bursting bridgewire, and in pressed RDX, initiated by
sing current through a column of RDX—graphite mixture
orporated in the charge. In the former case, a reaction wave
es out from the bridgewire at a velocity characteristic of low-
er detonation, with a transition to high-order detonation
urring at a reproducible induction distance which depends only
kly on the stored electrical energy. Induction distances from
mm to 17.5 mm were observed, depending on geometry and
ding density. Interactions of two pre-high-order waves were
estigated, as well as the ability of such waves to cause detonation
Composition B. In contrast, growth of explosion in the pressed
X appears to be governed, at least initially, by thermal mech-
sms; delays of more than 1 msec were observed between the
charge of the electrical energy and substantial explosion of the
rge.

INITIATION OF A LOW-DENSITY P.E.T.N. PRESSING
11621 BY A PLANE SHOCK WAVE.
E.Seay and L.B Seely, Jr.
appl. Phys. (USA), Vol. 32, No. 6, 1092-7 (June, 1961).
Plane constant-pressure shock waves were used to initiate
dge-shaped pressings of PETN (pentaerythritol tetranitrate).
e shocks entered the PETN from brass or Lucite plates. Shock
essures in the plates and depths at which the PETN was initiated
re measured with a streak camera. It was found that a 50 kbar
ock in the brass was barely sufficient to initiate granular PETN
essed to a density of 1.0 g/cm^3. This corresponded to a derived
essure of about 2½ kbar in the PETN pressing. It was further
own that the interstitial gas had no effect on the depth of initiation.

GAS FLOW AND DISTRIBUTION OF PRESSURE IN A
11622 DETONATING SPHERE IN SIMULTANEOUS
NITIATION ACROSS THE ENTIRE SURFACE. H.L.Selberg.
. Norske Vidensk. Selsk. Forhandl. (Norway), Vol. 32, No. 23,
34-8 (1959; publ. 1960).
The Chapman—Jouguet condition cannot be applied. The
etonation velocity exceeds the reaction velocity and produces a
eaction zone of significant length. E.R.Wooding

INFLUENCE OF WAVE REFLECTIONS ON THE
11623 DEVELOPMENT OF DETONATION.
J.Laderman and A.K.Oppenheim.
hys. of Fluids (USA), Vol. 4, No. 6, 778-82 (June, 1961).
One of the most significant features of the transition from deflagration to detonation is the dynamics of wave interactions occurring in the course of the process. Of particular interest is the effect of waves reflected from the closed end. The present study was based on a streak self-light photograph of a stoichiometric hydrogen—oxygen flame accelerating to detonation, and a simultaneous pressure transducer record taken at the closed end of the tube in the vicinity of the source of ignition. The photograph revealed considerable information on the flow field behind the flame, so that with the additional pressure measurement it was possible to deduce specific data on the changes of state in the gas, and the dynamic effects of wave reflections on the initiation of the process. The results were rationalized by means of a gas-wave dynamic analysis, yielding sufficiently complete wave diagrams of the phenomena to assess their importance with respect to the transition from deflagration to detonation.

MACH REFLECTION OF DETONATION WAVES.
See Abstr. 10538

CHEMONUCLEAR REACTORS. See Abstr. 10056

ELECTROCHEMISTRY

HEATS OF TRANSFER OF IONS.
11624 R.P.Rastogi, R.C.Srivastava and R.L.Blokhra.
Physica (Netherlands), Vol. 26, No. 12, 1167-70 (Dec., 1960).
The silver electrodes of an electrolytic cell were immersed in solutions of silver nitrate or silver acetate. Differences in temperatures of the electrodes cause differences in electric potential. The dependence of this e.m.f. on the concentration of the electrolyte was measured. It was found that solutions of both electrolytes produced the same e.m.f. at equal concentrations and temperature differences. It follows that the heat of transfer of silver ions is independent of the nature of the anions.
R.Eisenschitz

PHOTOCHEMISTRY
RADIATION CHEMISTRY

USE OF MASS SPECTRAL DATA IN RADIATION
11625 CHEMISTRY. J.H.Futrell.
J. chem. Phys. (USA), Vol. 35, No.1, 353-6 (July, 1961).
The quasi-equilibrium theory of mass spectra of Wahrhaftig et al. (Abstr. 3575 of 1961) is applied to the propane molecule ion to calculate the extent of unimolecular dissociation at 10^{-10} sec. This approximates the collision time for propane at moderate pressures and is therefore the ion distribution appropriate to irradiation studies. Two formulations of the theory are used, and it is concluded that the analytical mass spectrum of paraffin hydrocarbons is a good first approximation of the ion distribution in irradiated systems.

DISPERSIONS . COLLOIDS

NUCLEATION PROCESSES AND AEROSOL
11626 FORMATION. W.J.Dunning.
Disc. Faraday Soc. (GB), No. 30, 9-19 (1960).
The Volmer—Weber—Becker—Döring theory of homogenous and heterogeneous nucleation of liquid and solid particles from a supersaturated vapour phase is summarized briefly. The predictions of the theory are compared with the experimental results obtained by various authors using the cloud chamber method, the method of isentropic expansion through nozzles and the method in which a jet of vapour on issuing into a cool atmosphere becomes supersaturated. It is concluded that the theory is in fair agreement with the experiments and that supercooling by isentropic expansion through nozzles offers the most complete test of the theory. This method appears to have potentialities which would permit detailed analysis of nucleation and growth processes at high supersaturation.

NUCLEATION OF WATER AEROSOLS.
11627 B.J.Mason.
Disc. Faraday Soc. (GB), No. 30, 20-38 (1960).
Reviews recent studies of homogeneous and heterogeneous

nucleation of water aerosols involving vapour-to-liquid, supercooled liquid-to-solid and vapour-to-solid transitions with particular reference to recent investigations in the author's laboratory.

11628 ICE CRYSTAL NUCLEATION BY AEROSOL PARTICLES. N.H.Fletcher.
Disc. Faraday Soc. (GB), No. 30, 39-45 (1960).

The action of insoluble particles as ice crystal nuclei is discussed from a molecular viewpoint, and it is concluded that though some important issues are becoming more clearly understood, the theory is not yet sufficiently developed for practical application. A non-molecular approximate theory is then developed which gives adequate treatment of the nucleation activity of aerosols and particularly of the effects of particle-size distribution. The decay of nucleation activity caused by ultra-violet irradiation is also discussed. The results are illustrated with special reference to aerosols of silver iodide.

11629 PHASE CHANGES IN SALT VAPOURS. E.R.Buckle.
Disc. Faraday Soc. (GB), No. 30, 46-51 (1960).

A high-temperature cloud chamber technique devised for studying the freezing of supercooled ionic melts also provides data on phase changes involving salt vapours. Descriptions are given of the condensation, growth and evaporation of liquid and solid particles in clouds of alkali halides. Comparison is made with other work on salt aerosols and the results are examined in the light of recent knowledge of vapour constitution and the theory of nucleation in condensation and crystal growth.

11630 DROPLET INTERACTION IN AQUEOUS-DISPERSE AEROSOLS. D.P.Benton and G.A.H.Elton.
Disc. Faraday Soc. (GB), No. 30, 68-71 (1960).

Experimental evidence is given to show that the collection efficiencies of droplets in an aqueous aerosol are a function of the electrolyte concentration. A semi-quantitative indication is given of the influence of the Dukhin–Derjaguin diffusional electrokinetic effect on collection efficiencies of droplets of diameter approximately 3 μ [Kolloidnyĭ Zhurnal (USSR), Vol. 21, 37 (1959)]. A fully quantitative test of the theory of Dukhin and Derjaguin must await further experimental data.

11631 THE STABILIZATION OF WATER MISTS BY INSOLUBLE MONOLAYERS.
H.S.Eisner, B.W.Quince and C.Slack.
Disc. Faraday Soc. (GB), No. 30, 86-95 (1960).

Water mists containing droplets in the size range 2-20 μ radius were stabilized by reducing the evaporation rate of individual droplets. This was achieved by dispersing small quantities (0·05-0·2%) of a fatty alcohol in the water by means of a dispersing agent. As the water evaporates the alcohol forms an insoluble monolayer. Droplet life was increased by factors up to several hundred, depending on ambient conditions. A theory that explains the action of the monolayer on the basis of Fuchs' equation of droplet evaporation (1934) is shown to be adequate.

11632 ON THE DISCONTINUITY INVOLVED IN DIFFUSION ACROSS AN INTERFACE (THE Δ OF FUCHS).
P.G.Wright.
Disc. Faraday Soc. (GB), No. 30, 100-12 (1960).

The growth of aerosol particles, especially droplets of liquid, by condensation from the vapour phase is, unless the droplets are extremely small, largely controlled by diffusion through the surrounding medium. When, however, the radius of the drop is of the same order as the mean free path, the simple diffusion theory breaks down. Fuchs discussed this effect (1934) by analogy with the temperature jump at the surface of a heated wire, as a discontinuity in diffusion expressible in terms of a distance Δ, closely related to the mean free path. The validity of this theory was demonstrated experimentally by Birks and Bradley from studies on the rate of evaporation of drops (Abstr. 5390 of 1949). An explicit value of Δ was proposed by Bradley, Evans and Whytlaw-Gray (Abstr. 320 of 1947). A different value is shown to be implied by the calculations of Frossling and of Monchick and Reiss. An attempt is made, by a detailed examination of the experimental data of Bradley and co-workers, to ascertain which of these two values should be rejected. A remark of Fuchs, to the effect that Δ for a plane surface is two-thirds as great as Δ for a drop of vanishingly small radius, is considered in detail and a general formula is deduced for the variation of Δ with the curvature of the surface. It is shown that this dependence would be difficult to detect by experiment. The theory discussed is applic to the growth or evaporation of very small drops, especially in presence of surface films which reduce the condensation coeffici

11633 INVESTIGATION OF LONG-RANGE DIFFUSION FORCES BETWEEN WATER DROPLETS AND NON-VOLATILE PARTICLES. P.S.Prokhorov and L.F.Leonov.
Disc. Faraday Soc. (GB), No. 30, 124-9 (1960).

The long-range diffusion forces between droplets and solid particles were measured as a function of the distance between th and the relative humidity of the surrounding medium by means o torsion balance. The measurements show that these forces are inversely proportional to the square of the distance, and agree i order of magnitude with the theoretical calculations.

11634 THE MOTION OF A SMALL PARTICLE IN A NON-UNIFORM GAS MIXTURE.
S.P.Bakanov and B.V.Derjaguin.
Disc. Faraday Soc. (GB), No. 30, 130-8 (1960).

The problem of the behaviour of a small aerosol particle (smaller than the mean free path of gaseous molecules) in a non-uniformly heated gas mixture is examined on the basis of th Chapman–Enskog method [The mathematical theory of non-unifo gases. Cowling and Chapman. Cambridge: University Press (1939)]. The velocity at which the particle moves through such a mixture is calculated. A numerical computation is made for a CCl_4 + He mixture. Inversion of the particle velocity was observ i.e. the particle may be attracted to an evaporating drop and repelled from a growing one. By way of particlar cases the velo of motion was found for a particle in an isothermal binary mixt and in a simple non-uniformly heated gas.

11635 BEHAVIOUR OF IODINE VAPOUR IN AIR. A.C.Chamberlain, A.E.J.Eggleton, W.J.Megaw and J.B.Morris.
Disc. Faraday Soc. (GB), No. 30, 162-9 (1960).

Experiments with radio-iodine vapour at volumetric iodine concentrations below 1 $\mu g\ m^{-3}$ in the containment shells of the reactors Dido and Pluto show rapid adsorption on the walls and other surfaces. Adsorption on atmospheric nuclei is also an important factor which must be allowed for in designing iodine removal systems. There is also some evidence of the formation of a gaseous compound of iodine. When iodine vapour has equilibrated with air, nuclei, and permanent surfaces over a per of hours, the proportion of the airborne iodine, which is elemental iodine vapour, becomes small and the rate of removal slow.

11636 DISPERSED CARBON FORMATION IN ACETYLENE SELF-COMBUSTION. P.A.Tesner.
Disc. Faraday Soc. (GB), No. 30, 170-7 (1960).

Acetylene self-combustion results in the formation of hydro and dispersed carbon or carbon black. This process has been investigated by many authors; however, the mechanism of dispe carbon formation is not understood well enough. The present pa is an attempt to perform a theoretical calculation of the process of dispersed carbon formation in self-combustion of acetylene, i.e. when flame propagates in acetylene containing no oxygen. T calculation is based on representations developed by the author [Vniigaz Proc. Gostoptehisdat., Moscow, 1958, N3 (11) p. 34, and 7th Symposium on Combustion. London: Butterworth (1958) p. 576] involving two-stage formation of dispersed carbon (nucle tion and particle growth). A comparison of the calculated result with the experimental data shows good agreement.

11637 LIGHT SCATTERING OF COATED AEROSOLS. I. SCATTERING BY THE AgCl CORES.
E.Matijević, M.Kerker and K.F.Schulz.
Disc. Faraday Soc. (GB), No. 30, 178-84 (1960).

The preparation of silver chloride aerosols consisting of spherical particles of narrow size distribution by a condensation technique is described. The particle size distribution was deter mined by electron microscopy. Excellent agreement was obtain between the polarization ratio from light-scattering measureme and that calculated from the particle size distribution and theore tical scattering functions. Since the light scattering itself was insensitive to particle size distribution over a wide range of siz studied (radius, 200-800 mμ), the determination of particle size distribution from light scattering is not feasible for this range. However, there is an optimum range of size (r_{av}~55·0 mμ) wher particle size distribution can be obtained from light scattering.

LIGHT-SCATTERING BY VERY DENSE MONODISPERSIONS LATEX PARTICLES. See Abstr. 11638

LIGHT-SCATTERING BY VERY DENSE MONODISPERSIONS OF LATEX PARTICLES.

1638 .Churchill, G.C.Clark and C.M.Sliepcevich.
. Faraday Soc. (GB), No. 30, 192-9 (1960).

The effect of particle separation distance on the light-scattering perties of dispersions of closely sized spheres was investigated neasuring the transmission as the concentration was decreased lilution. The data were correlated in terms of a two-flux model. coefficient in this model was observed to be essentially constant n to a centre-to-centre distance of about 1·7 diameters between ticles and to vary less than 10% down to a centre-to-centre ance of about 1·4 diameters, corresponding to 28% solids by ume. Direct simulation of dilute aerosols having dimensions he order of kilometres is therefore feasible with very dense rosols having dimensions of the order of millimetres.

COMBUSTION OF LIQUID AND SOLID AEROSOLS.

11639 R.H.Essenhigh and I.Fells.
ic. Faraday Soc. (GB), No. 30, 208-21 (1960).

Discusses the mathematical similarities and chemico-physical similarities between the combustion mechanisms of liquid and id aerosols. The similarities are a consequence of the accepted ure of the respective rate-controlling steps of the reaction chanisms, conduction and diffusion, which are governed by ferential equations of the same form. The mass burning rates d burning times in both systems can be shown, therefore, to be portional respectively to the radius and square of the radius. e dissimilarities of the systems are to be found chiefly in the ferent physical positions of the reaction surfaces: for liquid ops this is at a flame surface which is a finite distance from the uid surface; for solid particles it is on the surface of, or inside, e solid itself. If experimental techniques become sufficiently nsitive, these dissimilarities may be found to generate second-der differences in the rate equations. The reaction control echanisms are discussed with particular emphasis on the alternate eory of surface rate control for solids leading to a linear burning-ne law in place of the accepted square law. Also considered are e possible role of microturbulence in enhancing reaction by inning the diffusion film, and the significance of macroturbulence aiding ignition and flame propagation.

THE MOLECULAR HYDROSTATIC ANALYSIS OF GIBBS' EORY OF CAPILLARITY. See Abstr. 10493

THE INFLUENCE OF A FOREIGN FILM ON EVAPORATION F LIQUID DROPS. See Abstr. 10494

PHYSICAL METHODS OF CHEMICAL ANALYSIS

MASS SPECTROGRAPHIC ANALYSIS OF INSULATORS USING A VACUUM SPARK POSITIVE ION SOURCE.

11640 A.J.Ahearn.
J. appl. Phys. (USA), Vol. 32, No. 7, 1195-7 (July, 1961).

Serious limitations are encountered in the analysis of insulators when conducting tubes packed with the powdered insulator are the electrodes of the vacuum spark. A general method of forming a vacuum spark directly between a conductor and a slab of insulator, which removes the above limitations, is presented. Mass spectral data of the insulators steatite and quartz are presented showing the presence of bulk impurities and surface contamination.

MASS SPECTROGRAPHIC DETECTION OF IMPURITIES

11641 IN LIQUIDS. A.J.Ahearn.
J. appl. Phys. (USA), Vol. 32, No. 7, 1197-1201 (July, 1961).

The mass spectrograph with the vacuum spark positive ion source distinguishes between bulk impurities in the electrodes and contaminants present on their surface. Surface contamination can be detected and identified when it is the equivalent of less than 0.01 monolayer in thickness. Impurities in liquids are studied by exposing an electrode to the liquid, thereby contaminating its surface. Two ways of contaminating an electrode surface are described: (a) electroplating of impurities onto the electrode, and (b) evaporation leaving residue on the electrode. Experiments with doped water demonstrate that impurities at a concentration of 10^{-9} atom fraction can be detected. Only about 10^{-10} g of impurity is needed for detection using the evaporation technique. Some applications are discussed.

IMPROVED FLUORIMETER FOR URANIUM ANALYSIS.

11642 E.N.Haran.
J. sci. Instrum. (GB), Vol. 38, No. 7, 273-7 (July, 1961).

A stable fluorimeter, easily operated and serviced, was developed. Drifts are reduced to a minimum by measuring only the alternating component of the fluorescent light. The exciting ultraviolet radiation is held at a constant level by a special light-stabilizing circuit. The radiation remains stable within ±1% for power line variations over the range of 200-250 V. The initial warm-up is less than 3 minutes compared with 10-15 minutes without the light-stabilizing circuit. The sensitivity of the instrument is to better than 10^{-9} gm uranium per fused pellet.

MODIFIED CHROMATOGRAPH TO RECORD HELIUM

11643 CONTENT OF NATURAL GAS STREAMS.
C.L.Klingman.
Rev. sci. Instrum. (USA), Vol. 32, No. 7, 822-4 (July, 1961).

The construction and procedure for use of a special-purpose chromatograph to analyse small amounts of helium in natural gas streams are described. The successful use of ordinary solenoid valves for column switching is unique. Automatic-zero circuitry is also mentioned. The instrument has proved to be useful in the reduction of wasted helium in the outlet gas streams from helium extraction plants.

GEOPHYSICS

11644 SEISMOMETER SOUNDS.
S.D.Speeth.
J. Acoust. Soc. Amer., Vol. 33, No. 7, 909-16 (July, 1961).

By time-compressing the output of a seismometer, it is possible to present seismographic data in an auditory display. Preliminary data suggest that the seismic sounds due to natural earthquakes may be distinguishable from those due to underground explosions. Some functions are presented to indicate how probability of detection varies with amount of initial training and distance of the seismometer from the explosion source. Other applications of auditory displays in the analysis of seismological data are suggested.

OSCILLATIONS IN A VISCOUS LIQUID WITH AN APPLICATION TO TIDAL MOTION. See Abstr. 10492

UNDERWATER SOUND REVERBERATION. See Abstr. 10568

11645 PHYSICS OF THE OCEAN.
G.E.R.Deacon.
Brit. J. appl. Phys., Vol. 12, No. 7, 329-32 (July, 1961).

Review of oceanographical wave studies.

ATMOSPHERE

(Troposphere and Stratosphere)

11646 A TWILIGHT METHOD OF DETERMINING THE VERTICAL DISTRIBUTION OF OZONE. A.B.Pittock.
Nature (GB), Vol. 190, 426-7 (April 29, 1961).

A new method for measuring the change of concentration of atmospheric ozone with altitude, within the earth's shadow at twilight, is proposed. Use is made of a balloon target floating at the 30-40 km level, and illuminated by direct sunlight, the sun being 5°-6° below the horizon. The reduction of the observations involves the comparison of measurements of earthward-scattered light from the target at two selected wavelengths, one at 6150 A (within the Chappuis absorption band), and the second at 4400 A in a spectral region free from O_3 absorption. Various practical difficulties that restrict the utility of the proposed method are enumerated, and briefly discussed. D.R.Barber

11647 SMALL-SCALE TURBULENT DIFFUSION IN THE ATMOSPHERE. F.Gifford.
Nature (GB), Vol. 190, 248 (April 15, 1961).

In Nature (GB), Vol. 187, 586 (1960) Clarenburg and Tang discussed the results of experiments by Frenkiel and Katz on the spread of smoke clouds in terms of Sutton's diffusion theory. The author disagrees with the conclusions reached for two main reasons: first, no account was taken of the relative diffusion of the particles about a centre of gravity which itself can move with the smoke; and secondly, because the diameter of the smoke puff used in the Clarenburg and Tang discussion is not the same quantity as the root mean square dispersion of diffusion theory. J.M.Stagg

PRINCIPLE OF INVARIANCE IN A SEMI-INFINITE INHOMOGENEOUS ATMOSPHERE. See Abstr. 10454

THE AGGREGATION OF SMALL ICE CRYSTALS. See Abstr. 11541

LIGHT-WEIGHT REFRACTOMETER FOR TROPOSPHERE MEASUREMENT. See Abstr. 10548

UPPER ATMOSPHERE IONOSPHERE

(See also Space Research. Abstracts on radiowave propagation in ionized media will also be found under Electromagnetic Waves)

11648 MEASUREMENT OF POSITIVE-ION DENSITY IN T IONOSPHERE BY SOUNDING ROCKET.
T.Ichimiya, K.Takayama, T.Dote, Y.Aono, K.Hirao, S.Miyazaki T.Sugiyama and T.Muraoka.
Nature (GB), Vol. 190, 156-8 (April 8, 1961).

Preliminary results taken with a Langmuir probe are give for one night-time and one day-time rocket firing. Profiles ar presented together with values of electron density taken from ionograms. The night profile shows thin layers of low ion dens while the day-time curve indicates an extended distribution wit little indication of valleys. H.J.A.Chi

NOTE ON IONOSPHERIC ACTIVITY. See Abstr. 10387

11649 ORIGIN OF THE D-REGION.
E.C.Y.Inn.
Planet. Space Sci. (GB), Vol. 5, No. 1, 76-8 (Jan., 1961).

It is suggested that in the D region, solar Lyman-α radiati may photoionize not only nitric oxide but also oxygen molecules a vibrationally excited state and ground electronic state. An experimental measurement of the relevant photoionization cros section for oxygen molecules is required to test this hypothesis D.M.Sci

11650 ON THE POLARIZATION OF THE OXYGEN RED LI AURORAE. J.W.Chamberlain.
Planet. Space Sci. (GB), Vol. 2, No. 1, 73-5 (Oct., 1959).

The report by Duncan (Abstr. 6638 of 1961) of 30% polariza of the 6300A OI line in a red aurora which had been plausibly e plained on a semiclassical basis from the highly preferential m of the exciting electrons, is examined critically from a more rigorous standpoint and found to be completely unpredicted. R.W.Nic

11651 TERRESTRIAL ACCRETION FROM THE SOLAR W C.M. de Turville.
Nature (GB), Vol. 190, 156 (April 8, 1961).

On extrapolating Unno's relation for turbulent motion in so corona and chromosphere (1959) to the conditions of interplane space, values of 4.33×10^8 cm/sec, and 11.65 particles cm^{-3} a obtained respectively for the solar proton velocity, and density the distance of the earth's orbit. These results are compatible recent experimental data obtained from radio observations of "whistlers" (Pope, 1960), and from Lyman-α records (Kupperi 1957); and with Van de Hulst's estimate of electron density at a heliocentric distance of 10^{11} cm, namely, 3×10^7 electrons cm They suggest also that the rate of solar H emission is $\sim 2.4 \times$ gm/sec. Since the energy of a proton moving with the above velocity is ~100 keV, the mean energy of the Van Allen (outer electrons will be one-half of this value, in agreement with Van Allen's results from satellite data. Applying the above results an estimate of the accretion rate of H captured by the earth fro the solar wind, the total mass accreted from the epoch of origi is found to be 1.7×10^{23} gm which, on oxidation to H_2O, would yield 1.53×10^{24} gm — in close agreement with the known tota mass of the oceans, namely, 1.42×10^{24} gm. D.R.Ba

11652 GEOPHYSICAL EFFECTS OF THE TRAPPED PAR LAYER. R.Jastrow.
Rev. mod. Phys. (USA), Vol. 32, No. 4, 947-50 (Oct., 1960).

Magneto-fluid Dynamics Symposium (see Abstr. 4700 of 19 Particle orbit calculations for a dipole magnetic field are quot showing that there is a class of "nearly trapped" orbits. A 10^0 deflection of the particle will usually convert a nearly trapped trapped orbit. This gives a mechanism for filling the outer Va Allen zone in about one day; the necessary 10^0 deflection is ass to occur between 60 000 and 90 000 km from the Earth, in a reg

ordered mixing of incident solar plasma with the Earth's
tic field. Another calculation is quoted as showing that the
ed particles will heat the upper atmosphere in the auroral
by about 1000°, either by conduction or convection, in agree-
with observation. O.Penrose

GEOMAGNETISM

11653 MEASUREMENT OF THE GEOMAGNETIC ELEMENTS. K.Whitham.
ods and techniques in geophysics. London: Interscience
shers. p. 104-67 [Contrib. Dominion Ob. Ottawa (Canada),
4, No. 7].
Full review article of the main features of the magnetic field associated with the earth and of the methods of measurement. These include torque, saturable core, Hall effect, magnetostriction, photo-precession methods and also methods using the deflection of free electrons in a magnetic field. It is considered that the electronic methods should be more fully developed since these give information which can be readily converted to digital form for automatic computation. C.A.Hogarth

11654 THE MAGNETIC PINCH EFFECT IN A FREE MOLECULAR PLASMA STREAM (A CONTRIBUTION TO THE THEORY OF FLOW AROUND THE MAGNETIC DIPOLE OF THE EARTH BY CORPUSCULAR STREAMS FROM THE SUN. V.N.Zhigulev.
Dokl. Akad. Nauk SSSR, Vol. 135, No. 6, 1364-6 (Dec. 21, 1960). In Russian.
For abstract, see Abstr. 6656 of 1961. [English translation in Soviet Physics—Doklady (USA), Vol. 5, No. 6, 1306-8 (May-June, 1961)].

BIOPHYSICS . PHYSIOLOGICAL PHYSICS

1655 MEDICAL ELECTRONICS. SECOND INTERNATIONAL CONFERENCE, PARIS, 24-27 JUNE, 1959.
ed by C.N.Smyth.
don: Iliffe and Sons (1960) 614 pp.
For abstracts of some of the papers presented at the above ference see Abstr. 8193-4, 8219-20, 8399, 9210 of 1961.

1656 CALCULATION OF ABSORBED DOSE. C.H.Cheek and V.J.Linnenbom.
ns Amer. Inst. Elect. Engrs III, Vol. 79, 1004-16 (1960) = Power aratus Syst., No. 51 (Dec., 1960).
Methods are summarized for the calculation of the absorbed of various radiations in organic materials composed of , N, O, F, Si, S and Cl. The radiations considered are: tromagnetic radiation, electrons, and neutrons. Tables of are given for use in the calculations. J.Thewlis

earing . Speech

11657 CONCERNING THE FUNDAMENTAL COMPONENT OF PERIODIC PULSE PATTERNS AND MODULATED BRATIONS OBSERVED ON THE COCHLEAR MODEL WITH RVE SUPPLY. G.v.Békésy.
Acoust. Soc. Amer., Vol. 33, No. 7, 888-96 (July, 1961).
Seebeck demonstrated that there are series of clicks for which urier analysis shows a very small fundamental component or none all, in spite of the fact that a distinct tone complex close to the ndamental component can be heard. Similarly, in a modulated tone, e modulation frequency as such may be heard without being present the Fourier analysis. This paper shows that on the model of the chlea the artificial basilar membrane vibrates at the place corresnding to the absent fundamental or the modulation frequency. The bration seems to be a consequence of the complicated travelling-ave patterns and their interferences. This may be of interest for me hearing theories.

11658 DETECTION OF AUDITORY SINUSOIDS OF UNCERTAIN FREQUENCY. D.M.Green.
. Acoust. Soc. Amer., Vol. 33, No. 7, 897-903 (July, 1961).
The decrease in the detectability of a gated sinusoidal signal in oise caused by deliberately introducing uncertainty about the signal's requency is no greater than 3 dB, even in an extreme condition of ncertainty. In this extreme condition the signal duration is 0.1 sec, nd the signal frequency is varied between 500 and 4000 c/s. This ffect is not critically dependent on signal duration. Moreover, the bservers not only detect the signal but display at least gross nformation about the frequency of the signal in the uncertain requency conditions. Several models, suggested in previous studies, re considered. The magnitude of the decrease observed in the data alls far short of the predictions of these models. An interpretation suggested by the data is that the observers in a detection task, even when a signal of fixed frequency is used, are highly uncertain as to the exact physical parameters of the signal. Another way of stating this assumption is to say that the observer never tests for the presence or absence of a signal on the basis of one simple hypothesis. From this assumption we sould expect little decrease in detectability from deliberately introducing frequency incertainty. This interpretation would suggest that same result would be obtained if time were the major experimental variable.

11659 NOISE-INDUCED PERMANENT THRESHOLD SHIFT AT 2000 cps AND 4000 cps. J.C.Nixon and A.Glorig.
J. Acoust. Soc. Amer., Vol. 33, No. 7, 904-8 (July, 1961).
Three samples of industrial workers were drawn from environments in which continuous, steady-state noise had average sound pressure levels in the octave bands from 150 to 4800 c/s that ranged from 77 to 96 dB. Each sample was sub-grouped according to length of time on job, yielding sub-samples whose mean times on job (mean exposure time for typical work years) ranged from less than one year to over 25 years. Median hearing levels were calculated for 2000 and 4000 c/s for each sub-sample. Age-effect (loss of auditory sensitivity due to ageing) corrections were applied to the median hearing-level values appropriate to the mean ages of the sub-samples. The resulting values were defined as noise-induced permanent threshold shift (NIPTS). It is shown that: (1) there is a maximum NIPTS produced at 4000 c/s which occurs within the initial 10 years of exposure to 8 hr/day exposures of continuous, steady-state noise of any intensity greater than 70-75 dB in the 1200-2400 or 2400-4800 octave bands; (2) the maximum NIPTS values which are produced at 4000 c/s are approximately equal to the noise-induced temporary threshold shift (NITTS) values predicted from the appropriate SPL's of each sample for 8 hr/day exposures; (3) there is no apparent maximum NIPTS occurring at 2000 c/s within the exposure range studied; and (4) NIPTS for both 2000 and 4000 c/s are monotonic functions of exposure time and SPL.

11660 FACTORS INFLUENCING THE PRACTICE EFFECT FOR AUDITORY THRESHOLDS. M.Loeb and C.Dickson.
J. Acoust. Soc. Amer., Vol. 33, No. 7, 917-21 (July, 1961).
Investigators have reported appreciable practice effects for low-frequency pure-tone absolute thresholds and no practice effects for thresholds at higher frequencies. It was suggested that practicing subjects are learning to discriminate between the signal and a low-frequency physiologic noise. No practice effect was observed at any frequency when thresholds were measured against a background of random noise. This finding would be predicted by the hypothesis advanced. However, efforts to induce a practice effect for a high-frequency tone by introducing a faint, high-frequency narrow-band background noise were unsuccessful. Implications of the findings are discussed.

11661 TIME VERSUS INTENSITY IN THE LOCALIZATION OF TONES. R.H.Whitworth and L.A.Jeffress.
J. Acoust. Soc. Amer., Vol. 33, No. 7, 925-9 (July, 1961).
Subjects were asked to match the lateral position of one tone, the "signal", by means of another, the "pointer". The two tones were presented alternately. The experimenter selected a combination of interaural time and intensity differences for the signal,

and the subject adjusted the interaural time difference for the pointer until it seemed to him to be in the same lateral position as the signal. Subjects having normal hearing perceived the signal in two places, one strongly affected by the difference of level at the two ears, the other almost wholly dependent upon the difference of time.

11662 CONTRIBUTION TO A STUDY OF THE "COCKTAIL PARTY PROBLEM". E.C.Cherry and J.A.Bowles.
J. Acoust. Soc. Amer., Vol. 32, No. 7, 884 (July, 1960).

It is stated that the binaural discrimination of two simultaneous speech sounds is easier if they are spacially separated, and this ability depends on the speech structure of the sounds. The present letter describes an experiment to compare the degree of binaural separability of two independent white-noise sources of identical bandwidth with that of two speakers reading different texts. It is stated that the results show that two voices are well separated but that two independent white noise sources could not be separated.
J.Berry

11663 INFORMATION IN SIMPLE MULTIDIMENSIONAL SPEECH MESSAGES. J.C.Webster.
J. Acoust. Soc. Amer.,Vol. 33, No. 7, 940-4 (July, 1961).

Simultaneous pairs of four-bit messages were presented to listeners at rates of two pairs every 4 sec (4 bits/sec), three pairs every 4 sec (6 bits/sec), four pairs every 4 sec (8bits/sec), and six pairs every 4 sec (12 bits/sec). Each message of the pair was either [a] or [i], said by a male or a female, as a question (rising inflection) or a statement (falling inflection), and heard in either the right or the left ear. Sequences were made that were balanced (1) between ears, (2) between male and female voices, (3) between [a]'s and [i]'s and (4) between questions and statements. The subject sometimes listened to both messages but usually listened only for the messages (1) in one ear, (2) of one voice, (3) of one vowel sound, or (4) of one inflection. The best subject could receive correctly about 6 bits/sec whether this was one of two messages at the 12 bits/sec rate or both of two at the 6 bits/sec rate.

11664 STUDIES ON THE ENDOLYMPHATIC D.C. POTENTIAL OF THE GUINEA PIG'S COCHLEA.
E.A.Rice and E.W.Shinabarger.
J. Acoust. Soc. Amer., Vol. 33, No. 7, 922-5 July, 1961).

The effect of loud sound on the endolymphatic d.c. potential was studied in both normal and hypoxic animals. When the integrity of the cochlear wall was maintained, the endolymphatic d.c. potential decreased by 5 mV with the onset of sound (1000 c/s below 140 dB) and recovered immediately when the sound was terminated. A intensities of 140 dB and above, the d.c. potential irreversibly decreased. The effect of sound on the d.c. potential was the sa for both normal and hypoxic animals. A negative d.c. potentia found in the scala media of hypoxic and dead animals. This po tial survived the life span of the post-mortem microphonics. positive d.c. potential returned on termination of hypoxia. Oxy deprivation resulted in the d.c. potential decreasing before the microphonics. The possible significance of these findings to t physiology of hearing is discussed.

Vision

11665 SUMMATION OF RETINAL POTENTIALS. J.C.Armington, D.I.Tepas, W.J.Kropfl and W.H.Her
J. Opt. Soc. Amer., Vol. 51, No. 8, 877-86 (Aug., 1961).

The operation of a computer which averages low-amplitude electroretinograms is described. The computer was used to detect electroretinograms which were recorded in an investigat of area-luminance and stray-light effects within the eye. Larg test stimuli were found to be more effective than small for proc ing responses of fixed size. Although the observers reported t stimulus spread over much of the retina, larger photopic respon appeared when the stimulus was centred on the fovea than on neighbouring areas. The waveform of the response was found t depend on both the colour and the position of the stimulus on the retina.

11666 UNILATERAL COLOR DEFICIENCY, CONGENITAL ACQUIRED. J.Cox.
J. Opt. Soc. Amer., Vol. 51, No. 9, 992-9 (Sept., 1961).

The literature on unilateral colour vision defects is review with particular reference to a unilateral deuteranope recently d cribed by Graham and his associates and by Walls (1955-9). A similar atypical unilateral deuteranomalous subject is describe where the colour vision defect has been acquired due to the dise retrobulbar neuritis. The hue discrimination and luminosity cu for this patient are compared with those found by Graham, and t possibility that retrobulbar neuritis could be responsible for a unilateral deutan defect with good visual acuity is discussed.

TECHNIQUE . MATERIALS

11667 PROGRESS IN NON-DESTRUCTIVE TESTING. VOLUME I. Edited by R.G.Stanford and J.H.Fearson.
London: Heywood (1958) 267 + vii pp.

For abstracts of some of the papers in the above volume see Abstr. 10199, 10206, 10287, 10363, 10572, 10614 and 10753 of 1961.

11668 MECHANICAL READER FOR OSCILLOGRAMS. P.Calcaterra, G.Stolz, Jr and V.Paschkis.
Rev. sci. Instrum. (USA), Vol. 32, No. 3, 358-9 (March, 1961).

The y displacement of the microscope carrier of an oscillogram chart reader is rapidly measured by coupling the lead screw to a printing revolution counter by a flexible shaft. An electric motor is used for the initial coarse drive. T.S.E.Thomas

11669 SPARK CUTTING OF METAL CRYSTALS. B.S.Chandrasekhar.
Rev. sci. Instrum. (USA), Vol. 32, No. 3, 368 (March, 1961).

Description, with illustration of a spark cutter used for cutting single crystals of indium 2.5 cm in diameter in about 24 The spark is produced by a 1700 μF condenser charged to 15 vo Some erosion of the cathode occurs. The method is applicable to tin, bismuth, aluminium and copper crystals. S.Weint

11670 LEAD WIRE ATTACHMENT TECHNIQUES FOR TH FILM STUDIES. R.I.George and R.B.McQuistan.
Rev. sci. Instrum. (USA), Vol. 32, No. 7, 855-6 (July, 1961).

Gold 0.005 in. wires, fired at 900°C onto a sapphire substra with a powder mixture of gold and Corning 7052 glass in polysty cement, give excellent ohmic contacts for semiconductor thin fi measurements. V.J.Hamr

LIST OF JOURNALS

The following list supplements the List of Journals published with the January number of Vol. 64 (1961). Reprints of the List of Journals can be obtained from The Institution of Electrical Engineers, Savoy Place, London, W.C.2, price 2s.0d. post free. The addresses given are believed to be correct at the date of publication, but no responsibility can be accepted for errors.

Bull. Inst. Chem. Res. Kyoto Univ. (Japan)	Bulletin of the Institute for Chemical Research, Kyoto University Kyoto.
Ingenieur (Canada)	L'Ingénieur L'Association des Diplômés de Polytechnique, C.P. 501, Snowdon, Montreal 29.

ERRATA

Abstr. 6707 (1960) line 2: for "ISTROPIC [ELASTIC] SHERES" read "ISOTROPIC [ELASTIC] SPHERES"
Abstr. 8751 (1960) line 2: for "P.Tamarkins" read "P.Tamarkin"
Abstr. 9381 (1960) line 1: for "SYNCHROCYLOTRON" read "SYNCHROCYCLOTRON"
Abstr. 10136 (1960) line 2: for "E.A.Anderson" read "E.E.Anderson"
Abstr. 10931 (1960) line 2: for "Yu.N.Barabenekov" read "Yu.N.Barabanekov"
Abstr. 11248 (1960) line 3: for "M.A.Pomeranyz" read "M.A.Pomerantz"
Abstr. 13806 (1960) line 2: for "A.W.Mc Reynolds" read "A.W.McReynolds"
Abstr. 16177 (1960) lines 1 and 2: for "IRRADAITED" read "IRRADIATED"
October (1960) p. 1595, col. 2: for abstract number "161678" read "16178"
Abstr. 1692 (1961): title and author should read: "AN INTERPRETATION OF THE LORENTZ TRANSFORMATION CO-ORDINATES. S.J.Prokhovnik"
Abstr. 9248 (1961) line 4: for "991" read "991-2"; line 10: for "infrared" read "inferred"
Abstr. 9265 (1961) line 9: for "A^{38}" read "A^{39}"

AUTHOR INDEX

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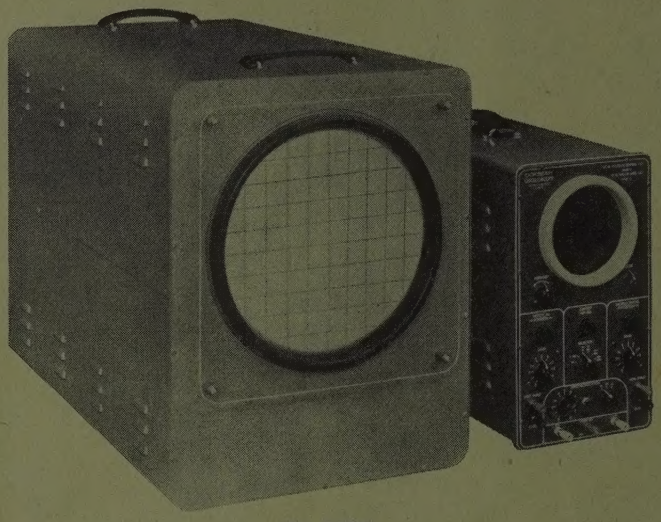

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